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BIRD STRIKE COMMITTEE EUROPE

WORKING PAPERS

19 th. MEETING

BSCE

AEROPUERTOS ESPAÑOLES

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13. ABSTRACT (Maximum 200 words)

The Bird Strike Committee Europe consists of civil and military participants from Europe with a common interest in the bird strike problem. Attendance is open to participants from other parts of the world. Annual Meeting Proceedings include Chairman's Report, Working Group Reports and Presented Papers:

TABLE OF CONTENTS: See Page 3.
Revised Index for BSCE Working Papers Issued During the Period 1966-1988, Including Papers Presented at the 1977 World Conference in Paris Which Was Organized Partly by BSCE

14. SUBJECT TERMS
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BIRD STRIKE COMMITTEE EUROPE

WORKING PAPERS

19 th. MEETING

BIRD STRIKE COMMITTEE EUROPE

WORKING PAPERS

19 th. MEETING

BSCE

19th MEETING
Madrid 23-26 May 1988

AEROPUERTOS ESPAÑOLES

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Information circular

(Mr. Dahl, Chairman BSCE)

1. ORGANIZATION

The 19th meeting of the Bird Strike Committee Europe will be held in Madrid on 23-27 May 1988 and will be organized by the Spanish Airports Authority and the Chairman of BSCE.

2. ADRESSES

Spanish Airports Authorities
Att.: M.ª Eugenia Llorens Beltran de Heredia
Jefa de la Unidad de Relaciones Internacionales
Ministerio de Transportes, Turismo y Comunicaciones
Organismo Autonomo "Aeropuertos Nacionales"
Arturo Soria, 109
E-28043 - Madrid
SPAIN

Tel.: 413 40 13 (ext. 456)
Telex: 44533 dgan/e

Mr. H. Dahl
Chairman of BSCE
Civil Aviation Administration
Luftfartshuset
P.O. Box 744
Ellebjergvej 50
DK-2450 Copenhagen SV
DENMARK

Tel.: +45 1 44 48 48 (ext. 275)
Telex: 27096 caa/dk
Facsimile: +45 1 44 03 03

3. LOCATION OF MEETING

Hotel Melia Madrid
Princesa, 27
E-28008 Madrid
SPAIN

Tel.: (91) 241 82 00 and 241 84 00
Telex: 22537 metel e

4. AGENDA

DATE	MORNING	AFTERNOON
Monday 23 May	1000: Steering Committee 1100: Plenary 1200-1330: Analysis Working Group 1330-1530: Lunch	1530-1800: Analysis Working Group
Tuesday 24 May	1000-1330: Radar Working Group 1330-1530: Lunch	1530-1800: Structural Testing WG 1530-1800: Bird Movement Low Level WG
Wednesday 25 May	1000-1330: Aerodrome Working Group 1000-1330: Communications WG 1330-1530: Lunch	1530-1800: Aerodrome Working Group
Thursday 26 May	1000: Plenary	1530: Technical Visits
Friday 27 May	1000: Plenary	

5. WORKING PAPERS

Should be sent to the Chairman and, if received before 1 April 1988, will be published in a bound set to be collected at the beginning of the meeting.

6. INVITATIONS

Invitations for the meeting and application forms will be sent in November 1987.

7. HOTEL ACCOMMODATION

HOTEL reservation at the Melia Hotel can be booked by sending the enclosed application form to BAI, Promoción de Congresos S.A., not later than by 20th. November, 1987, with an enclosed deposit of US $40 per person.

If you choose not to stay at the Melia Hotel, you are strongly advised to make hotel reservation as early as possible due to the fact that hotel accomodation in Madrid at the time of the Conference will be difficult to obtain.

Invitation letter

(Mr. Dahl, Chairman BSCE)

BSCE 19/WP 2
Madrid, May 1988

INVITATION LETTER

1. Bird Strike Committee Europe and the Spanish Airports Authority cordially invite you to attend the 19th meeting of BSCE which will be held in Madrid from 23 May 1988 and end on 27 May 1988.

2. Location of meeting:

   Hotel Melia Madrid
   Princesa, 27
   E-28008 Madrid
   SPAIN

   Tel.: (91) 241 82 00 and 241 84 00
   Telex: 22537 metel e

3. Address of the organizing committee:

   Spanish Airports Authority
   Att.: M.ª Eugenia Llorens Beltran de Heredia
   Jefa de la Unidad de Relaciones Internacionales
   Ministerio de Transportes, Turismo y Comunicaciones
   Organismo Autonomo "Aeropuertos Nacionales"
   Arturo Soria, 109
   E-28043 - Madrid
   SPAIN

   Tel.: (91) 413 40 13 (ext. 456)
   Telex: 44533 dgan/e

   Mr. H. Dahl
   Civil Aviation Administration
   P.O. Box 744
   Ellebjergvej 50
   DK-2450 Copenhagen SV
   DENMARK

   Tel.: +45 1 44 48 48 (ext. 275)
   Telex: 27096 caa/dk
   Facsimile: +45 1 44 03 03

4. Agenda:

   Registration of the parcipants will be held on 23 May 1986 between 0830 and 1000 local time.

Monday, 23 May	1000	Steering Committee
	1100	Plenary
	1200-1330	Analysis Working Group
	1330-1530	Lunch
	1530-1800	Analysis Working Group
Tuesday, 24 May	1000-1330	Radar Working Group
	1330-1530	Lunch
	1530-1800	Structual Testing Working Group
	1530-1800	Bird Movement Low Level Working Group

Wednesday, 25 May	1000-1330	Aerodrome Working Group
	1000-1330	Communications Working Group
	1330-1530	Lunch
	1530-1800	Aerodrome Working Group
Thursday, 26 May	1000	Plenary
	1330-1530	Lunch
	1530	Technical visits
Friday, 27 May	1000	Plenary

5. Terms of reference of BSCE:

Bird Strike Committee Europe consists of civil and military participants from Europe with a common interest in the bird strike problem. Attendance is open to participants from other parts of the world.

The Bird Strike Committee Europe shall:

a) collect, analyse and circulate to all concerned data and information related to the bird strike problem in the European region;

Note: This data and information should include the following:

1. Civil and/or military data collections and results of analyses on bird strikes to aircraft.

2. Results of any studies or examinations undertaken by states in the various fields related to the bird problem.

3. Any information available in the field of design and structural testing of airframes related to their resistance to bird strikes.

4. Any other information having a bearing on the bird strike question and the adding to the various problems involved.

b) study and develop methods to control the presence of birds on and near aerodromes;

c) investigate electro-magnetic wave sensing methods (e.g. radar, invisible light, etc.) for observing bird movements;

d) develop procedures for the timely warning of pilots concerned where the existence of a bird hazard has positively been established;

e) develop procedures, if appropriate, for the initiation by air traffic control of avoiding action where existence of a bird hazard has positively been established;

f) develop procedures enabling a quick and reliable exchange of messages regarding bird hazard warnings;

g) develop any material (e.g. maps, back-gound information, etc.) intended for inclusion in Aeronautical Information Publications;

h) aim at a uniform application, throughout the European region, of the methods and procedures and the use of material developed in accordance with b) to g) above, provided suitable trials have proved their feasibility, and monitor developments in this respect.

6. Terms of reference of Working Groups:

Radar Working Group:

Matters associated with the use of radar and other sensors in the surveillance, the identification and the assessment of bird presence and movements.

Bird Movement And Low Level Flight Working Group:

Study of bird concentration and movements, drawing up of special bird hazard maps for informal and planning purposes and developing of preventive measures to minimize the bird hazard to low-flying aircraft.

Communications Working Group:

Study of all problems relating to the transmission of information on bird movements which could present a hazard to aviation and the provision of such information to air traffic services.

Aerodrome Working Group:

a) Preparation of general recommendation to minimize bird problems at and around aerodromes.

b) Correlation of bird control research between the countries.

Analysis Working Group:

Collection, analysis and circulation of data and information relating to bird strikes in the European Region.

Structural Testing Working Group:

1. Exchange of information on the results obtained from:
   a) bird impact research testing of materials, structural specimens, widescreen, etc.;
   b) tests to show compliance with airworthiness requirements.
2. Exchange of information on methods of prediction.
3. Establishment of liaison on future research programme in order to avoid dublication.
4. Assistance of national organizations in the production of design guidance material for bird impact resistant airframes.

7. Reception.

Will be announced at the beginning of the meeting.

8. Technical visits.

Will be announced at the beginning of the meeting.

9. Ladies' programme.

Will be announced at the beginning of the meeting.

10. Notification of participation.

Participation in the meeting should be notified to the Chairman by filling out the attached paper, Appendix 1, and preferably before 1 April 1988.

11. Working papers and presentations.

Working papers received before 1 April 1988 will be published in a bound set to be collected at the start of the meeting and papers arriving after 1 April 1988 will be published together with the report of the discussions and recommendations in a second part of the report of the meeting.

The Chairman of the meeting in co-operation the Steering Committee will decide whether a working paper should be presented in the Plenary or in a working group. Presentations should be not more than 20 minutes in order to allow time for discussion. English shall be used.

In order to obtain consistency of presentation, the following shall be observed:

Type

Papers must have a good quality black print on A4 208mm x 295 mm (8 1/4" x 11 1/2") paper with 20 mm margins on all sides (to allow for printing and binding).

It will be advantageous to draw a box 20 mm in from paper edge on all sides on a blank sheet of paper to use as a guide behind pages being typed or word processed. Due to problems with reproduction and readability, low quality dot matrix printing is not acceptable. Print of type of 10 or 12 pitch is preferred.

Format

Text should be single spaced with double spacing between paragraphs with text including new paragraphs being left (or both) margin justified.

Front Sheet

Each paper submitted should start with a front sheet which has at the top right hand BSCE 19/ then a space for the organisers to insert a Working Paper number. Immediately below this should be typed Madrid May 1988. In the top third of the page should be typed the papers title in capital

letters and underlined and underneath it the authors name and affiliation in upper and lower case. Below this should be a brief summary of not more that 200 words.

The body of the paper should be started on a new sheet.

Headings and Paragraph Numbering

All headings shall be left-justified and underlined (or bold if available). Section headings shall be in upper-case and each section numbered /to ... Sub-headings shall be in upper and lower case and numbered 1.1, 1.2 etc. Sub-paragraphs may be lettered if desired. The above will make it easier to refer to paragraphs during discussion etc.

Figures and Tables

All figures and tables should be titled across the top with "FIGURE" or "TABLE" in capital letters followed by the number. The title should follow on the same line in capital and lower case letters.

Page Numbers

Pages shall be numbered in light pencil at the bottom centre of each page. The organisers will renumber all pages when compiling the Proceedings.

12. Hotel reservations:

Referring to the information contained in the INFORMATION CIRCULAR, BSCE 19/WP 1, you are strongly advised to make the hotel reservation as early as possible due to the fact that hotel accommodation in Madrid at the time of the conference will be difficult to obtain.

Yours sincerely,

H. Dahl

H. Dahl

Chairman

Revised Index for BSCE Working Papers. Issued during the period 1966-1988. Including papers presented at the 1977 World Conference in Paris which was organized partly by BSCE.

(Chairman)

BSCE 19/WP 3

Madrid, 23-28 May 1988

REVISED INDEX FOR BSCE WORKING PAPERS ISSUED DURING THE PERIOD 1966-1988, INCLUDING PAPERS PRESENTED AT THE 1977 WORLD CONFERENCE IN PARIS WHICH WAS ORGANIZED PARTLY BY BSCE

(Presented by BSCE Chairman)

In the below index, the first figure in the right column indicates the number of the BSCE meeting (however, the World Conference is indicated as WC) and the second figure indicates the working paper number followed in papers presented at the World Conference and at the BSCE meetings in 1984 and 1986 by page number(s) in the report.

The fact that a paper appears below does not imply that the contents of the paper have been endorsed by BSCE.

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0.2 Bird Numbers In Space And Time

0.3 Bird Migration

0.4 Bird Ecology

0.5 Bird Ethology

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1.3 Statistics On Military Aircraft Strikes

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0. Birds - Not Directly Related To Bird Strikes

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3.	Bruderer, B.	Bird observations at Zürich Airport	13/18
4.	Suter, V.	Roosting and feeding flights of black-headed gulls in the region of Zürich Airport	13/19
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2.	Thorpe, J.	Reportable accidents caused by bird strike/ingestion worldwide 1973	10/5A
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3.	Houghton, E.W. and Blackwell, F.	Use of bird activity modulation waveforms in radar identification	7/1
4.	Rochard, J.B.A. and Horton, N.	Birds killed by aircraft in the United Kingdom 1966/1976	12/4
5.	Lind, H.	Identification of bird remains as part of the bird strike reporting procedure	13/3
6.	Buurma, L.S. and Brom, T.G.	The quality of identification: A microscopic key to the determination of feather remains	14/19
7.	Buurma, L.S. and Brom, T.G.	The quality of identification: Its effects on bird strike statistics	14/20
8.	-	List of persons/organizations to undertake identification of feather remains	15/30
9.	Brough, T.	Average weights of birds	17/10 p. 164
10.	Laybourne, R.C.	Identification of bird remains from bird/aircraft incidents by the micro-structure of the downy part of the feather	17/24 p. 282
11.	Belgian Airforce	Strategies for the identification of bird remains from bird strikes	18/12 p. 113
12.	Brom, T.G.	Identification of bird remains for bird strike analysis: A litterature synopsis	18/23 p. 255
13.	Brom, T.G.	The analysis of feather remains: Evaluation and perspectives	19/24

2. Airports/Airfields

2.1 General

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1.	Stortenbecker, C.	Bird problems at Schiphol Airport	2/3
2.	Finley, H.R.	Canadian manual for the guidance of individuals in dealing with bird hazards	3/4
3.	Hild, J.	Bird fluctuations on airfields during the year	4/11
4.	Keil, W.	Ecological research in aerodrome traffic zone and its results	7/6
5.	Kuhring, M.S.	Projects of associate committee on bird hazards to aircraft. National research council of Canada	7/7
6.	Hild, J.	Bird strike situation in German airforce	7/9
7.	Becker, J.	General consideration about entomological investigations on airfields	8/9-1
8.	Laty, M.	Le problème d'oiseaux en France, activités de recherche	8/11-4
9.	Solman, V.E.F.	Report made in Canada since last meeting	9/9
10.	Laty, M.	Au sujet des nouveaux risques de collision presentès par les mouettes rieuses sur l'Aeroport de Nice, Côte d'Azur	9/10
11.	Austin, T.S.	Bird strike, the airport managers' brief	11/24
12.	Austin, T.S.	Talk - bird control units in the RAF	11/29
13.	Buurma, L.S.	Establishment of bird control units at 6 Dutch airbases	12/3
14.	Brough, T.	Some behavoural aspects of airfield bird control	WC/11 p. 117
15.	Campbell, R.B.	Planning and control of bird hazard reduction at airports in the Transport Canada system	WC/12 p. 146
16.	Dahl, H.	Organization of the scaring away of the birds	13/12C
17.	-	Measures available to the airport management for the reduction of bird strike risk	13/27
18.	Harrison, M.J.	American initiative in bird control on a national scale	14/6
19.	Keil, W.	Regulations for the bird strike representatives of the civil airports in Germany	14/15

20.	Keil, W.	Experiences about the bird strike regulations of the Federal Ministry of Transport since 1974, especially about the biotop experiences	14/16
21.	Briot, M.	Solutions propres à la France: Sensibilisation des personels	14/23
22.	Jakoby, V.E.	Is it necessary to destroy birds on aerodromes?	14/26
23.	Marcal, G.	Bird risk and air safety	14/29
24.	Rooseleer, G.	"Know your bird" poster	15/14
25.	Rooseleer, G.	A proposal for a check list for bird strike prevention on airfields	15/15
26.	Short, J.	Handbook on bird management and control	15/17
27.	Dahl, H.	Code of procedure	15/21
28.	S.T.N.A.	The airport bird problem	15/24
29.	Hild, J.	New organization of German board bird strike prevention	15/25
30.	Helkamo, H.	Bird control at Helsinki-Vanta Airport in 1978/1981	16/4
31.	van Geuns, A.H.	Bird strike prevention at airports. A continuous story	16/5
32.	Laty, M.	Birds on airports. Some reasons for their presence	16/9
33.	Rogachev, A.I.	The status of aeronautical ornithology problem in the civil aviation of the USSR	16/10
34.	Jakoby, V.E.	Sphere of action and the efficiency of the means at aerodromes for the prevention of collisions between birds and aircraft	16/12
35.	Dahl, H.	Economical and operational aspects of bird prevention measures	16/18
36.	Italian Civil Aviation Authority	Airports survey and bird strike statistics 1981/82/83	17/13 p. 198
37.	Hild, J.	Recommendations for bird control on airports	17/15 p. 227
38.	Solman, V.E.F. and Thurlow, J.	Reduction of wildlife hazards to aircraft	18/10 p. 103
39.	Thomas, C.	The development of an effective bird detection and dispersal programme	19/10
40.	Morera, P.	Evaluation of bird populations at Spanish Airport: Outline and results	19/21
41.	Ruiz, J.	Present state of bird strike hazards at Spanish airports	19/22

42.	Brough, T.	An overview of aerodrome bird control and related activities in the UK	19/26
43.	Scorer, T.	Bird strikes prevention is better than legal liability	19/32
44.	Thomas, C.	How meaningful are bird strike statistics	19/35
45.	Brough, T.	Aerodrome measures book: Revised entries for the UK	19/38

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1.	Karlsson, J. and Turesson, L.-O.	Preliminary works before the opening of Sturup Airport for the purpose of reducing the risk of bird strikes	8/9-3
2.	Maron, J.	Bird strike problems of the projected airport München 2	11/27

2.3 Habitat Management

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2.	Hild, J.	Agricultural investigations for expelling birds on German airbases	3/5
3.	Stortenbeker, C.W	Ecological research at Schiphol Airport, Amsterdam	3/6
4.	Hild, J.	Agricultural investigations on German airbases	4/8
5.	Brough, T.	Experimental use of long grass in the UK	6/1
6.	Hild, J.	Mixtures of grass-seed for airports	6/4
7.	Becker, J.	General considerations about entomological investigations on airfields	8/9-2
8.	Laty, M.	Au suject des nouveaux risques de collision présentés par les mouettes rieuses sur L'aeroport de Nice, Côte d'Azur	9/10
9.	Hild, J.	Growth prohibiting substances and effects on grass land areas	11/13
10.	Hild, J.	A new problem on scaring birds on airfield induced by replanting trees and scrubs	11/14
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12.	Stone, R.J.	Synergised amonium aluminium sulphate in the control of birds at airports	11/23
13.	Dar, D.	Summary of tests carried out at the international Ben Gurion Airport Lod with bird repellent RETA	11/26
14.	Stone, R.J.	Development of the theoretical construct of synergised aluminium amonium sulphate for the control of birds at airports	12/8
15.	Dar, D.	Treatment for repelling birds at Ben Gurion Lod international airports, Israel during 1976/77	12/9
16.	Hild, J.	Methods of ecological research	WC/15 p. 137
17.	Laty, M.	Interpretation l'ecologique des oisaux	WC/16 p. 122
18.	Maron, J.	Aspects on the economic utilization of the area under consideration of the bird strike problem	WC/22 p. 140
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20.	Dahl, H.	Use of chemicals to make the soil of the airport surroundings unattractive	13/12A
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22.	Riley, M.	Preliminary laboratory and field trials of the chemical repellent synergised amonium aluminium sulphate on rodents and principally birds	13/25
23.	Laty, M.	Essais en cours du répulsive RETA	13/28
24.	Heijink, J. and Buurma, L.S.	Practical and economical aspects of grass land management on some Dutch airbases	13/33
25.	Suaretz, S. and Agat, J.	Summary of results of spraying with RETA repellent at Ben Gurion Airport 1974-1979	14/32
26.	Dahl, H.	Experiments on and the use of chemical agents as bird repellents on aerodromes	15/7
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33.	Thompson, M.M.	Toxic perches for control of pest birds in aircraft hangars	18/9 p. 96
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35.	Hild, J.	Fundamental experiences and suggestions for biotope-management procedures on international airports	19/16
36.	Glennung, A.M.	Birds at Copenhagen Airport	19/17
37.	Bekker, A., Buurma, L.S.	Visual lapwing counts versus aircraft-lapwing strikes	19/28
38.	Brough, T.	Aerodrome measures book Revised entries for the UK	19/38

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3.	Møllen, G.U.	The utilization of the distress call for scaring birds from airfields (in Norway)	6/3
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10.	Briot, J.L.	Last French experiments concerning bird strike hazards reduction (1981-1986) (Noisy synthetic sounds along the runways)	18/18 p. 205
11.	Efanov, B.	Increase of effeciency of the mobile bio-acoustic system for scaring birds within the airport area	18/32 p. 352
12.	Fürbeth, H.	Radio-controlled bird defense system (Steffan system)	19/13
13.	Briot, J.L.	The use of synthetic noise generators in French airports	19/33
14.	Brough, T.	Aerodrome measures book Revised entries for the UK	19/38

2.4.2 Use Of Birds Etc. (Real Or Mock-Up Birds) And Model Aircraft

1.	Slot, J.W.	Hawks at Leeuwarden airfield	3/3
2.	Mikx, F.H.M.	Hawks af Leeuwarden airbase	4/10
3.	de la Fuente, R.	Use of falcons for the control of bird hazardous to aircraft	6/5
4.	Stortenbeker, C.	Bird dispersal with acoustical and visual means	7/3
5.	Stout, J.F.	Dispersal of gulls from the airport environment	10/8
6.	Blokpoel, H.	The use of falcons to disperse nuisance birds at Canadian airports: An up-date	WC/10 p. 179
7.	Stout, J.F.	An evaluation of gull model induced dispersal of sea gulls	WC/19
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13.	Briot, J.L.	Last French experiments concerning bird strike hazards reduction (1981-1986) Falconery and radio controlled model aircraft	18/18 p. 203
14.	Bivings, A.E.	Advantages and limitations of the radio-controlled aircraft in bird dispersal	19/31
15.	Brough, T.	Aerodrome measures book Revised entries for the UK	19/38

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4.	Laty, M.	Startling of birds by light, experimental devices, current research	11/11
5.	Herzig, M.	Approaches to protect endangered areas on airports from bird population by xironet bird protection netting	13/15
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11.	Soucaze-Soudat,	Self-contained portable laser transmitter	19/43

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3.1 Use of Land, Vegetation, Garbage Dumps, Moist Areas, Artificial Lakes, Sanitary Landfields, Sewage Installations, And Sanctuaries

1.	Laty, M.	Providing of a roosting area for the black-headed gulls at the Nice airport away from the airport	10/13
2.	Dahl, H.	Garbage dumps in the vicinity of airports	13/10A
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2.	Hild, J.	European bird migration map	3/12
3.	Hild, J.	Bird hazard maps, Europe	7/8
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5.	Heirman, J.	A Belgian bird strike risk map based on numbers of birds to the unit of area	10/11
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8.	Karlsson, J.	Survey of bird concentration areas as a tool in aviation safety work with an example from Sweden	12/13
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12.	Hild, J.	Biophenological observation- and information service in German airforce. A help for bird strike risk forecast	13/20
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8.	Lieth, H.	Some remarks on the influence of bio-meteorology on birds' life	15/12
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7.	Houghton, E.W.	ATC and bird radar surveillance without tears	6/12
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Some bivariate probability models applicable to aircraft collision with birds

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SOME BIVARIATE PROBABILITY MODELS APPLICABLE TO AIRCRAFT COLLISION WITH BIRDS

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SUMMARY

Collisions between aircraft and birds are the subject of growing interest. The uncontrollable nature of those factors which cause these collisions suggests that a probability model might be used to express the relationship between the number of birdstrikes and the number of damage cases and the relationship between the number of birdstrikes and the losses. It is clear that the number of damage cases (Y) and the losses (Z) are both positively correlated with the number of birdstrikes (X). In this investigation, two bivariate probability models will be studied: one for the joint distribution of the number of birdstrikes and the number of damage cases; and one for the joint distribution of the number of birdstrikes and the losses. In both models, the number of birdstrikes X at a certain location during a given time interval is assumed to follow a Poisson distribution with parameter β_1. In the first model, suppose that the variable Y_i assumes the value 1 if the ith aircraft collision with birds is associated with damage case and Y_i assumes the value 0 if the ith aircraft collision with birds is not associated with damage case, and these events occur with probabilities p and q=1-p, respectively. Thus, the variable $Y = Y_1 + Y_2 + \dots + Y_X$ represents the number of damage cases in a total of X aircraft collisions with birds. Clearly, $Y \leq X$, and the bivariate distribution f(x,y) represents the joint distribution of the number of birdstrikes and the corresponding number of damage cases. In the second model, the variable Z_i shall denote the losses in the ith aircraft collision with birds and it may take the values 0,1,2, ... In this case, the Z_i are assumed to follow a Poisson distribution with parameter β_2. Thus, the variable $Z = Z_1 + Z_2 + \dots + Z_X$ represents the losses in X aircraft collisions with birds, and the bivariate distribution g(x,z) represents the joint distribution of the number of aircraft collisions with birds and the corresponding losses. In this paper, the examples illustrating data processing are given where the losses associated with aircraft collisions with birds are expressed in terms of conventional units of the cost.

1. INTRODUCTION

Although birdstrikes are considered to pose one of the major problems to flight safety in the jet age by many aviation experts, the extent to which the problem is taken seriously varies enormously, both in terms of time and in terms of country and company. The relatively low rate of serious birdstrikes in civil aviation might explain why certain organizations, which have probably not suffered any damage or near-accidents for years don't give this subject the priority it deserves. For them it should be worth considering the fact that, despite the difficulty in confirming a birdstrike as the initial cause of an accident and the fairly general reluctance to disclose details about accidents, over 30 crashes of civil aircraft have been reported worldwide due to birdstrikes (Thorpe, 1982).

The above reference serves to illustrate the fact that flight safety is a problem of great importance. Various reasons may explain the widespread reluctance to tackle the birdstrike problem. Firstly, the design of a fully birdproof aircraft seems to be an unattainable ideal, due to engineering and economical constraints, whilst competition among aviation industries may also be a factor. Establishing internationally agreed flight safety requirements is far from easy. The by itself reasonable principle to accept a certain, very limited risk inevitably implies the necessity to reach a consensus on the extent of the acceptable risk. The same applies to flight restrictions to avoid situations of high bird density, especially in military low level training. Appreciable financial repercussions also hamper the implementation of internationally agreed standards for bird control on airfields. Secondly, the birdstrike problem is a very complex one and reflects the diversity and partial unpredictability of nature. As a result the problem can be, and actually is, interpreted in many ways. The same applies to preventive measures. The success of such measures is difficult to quantify, especially because there is usually no comparable situation to serve as reference. In addition, successes tend to be exaggerated while failures often remain undisclosed.

It is not the intention of this paper to review the entire birdstrike problem. Virtually all aspects have been dealt with in the book of Blokpoel (1976). The purpose of the present contribution is to focus attention on the probability models suitable for analysis of birdstrike statistics and the determination of birdstrike risks.

2. THE POISSON-BERNOULLI MODEL

Suppose that the number of aircraft collisions with birds X recorded at a specific location in a given time interval has a Poisson distribution with probability function

$$f_1(x) = e^{-\beta_1}\beta_1^x/x! \ , \ x=0,1,2, \ldots \tag{1}$$

Let Y_i be an indicator variable associated with ith aircraft collision with birds such that $Y_i=1$ if the ith collision is damage case of aircraft, and $Y_i=0$ if ith collision is no damage case. Further, suppose that the probability function of Y_i is given by

$$Pr(Y_i=1) = p ,$$
$$Pr(Y_i=0) = q = 1-p. \tag{2}$$

Also, the total number of damage cases Y among the X aircraft collisions with birds occurring in the jth time interval is

$$Y = Y_1+Y_2+ \dots +Y_X. \tag{3}$$

Thus, if the Y_i are assumed to be mutually independent, then the conditional distribution of Y given that X=x is binomial with parameters x and p. That is,

$$f(y;x) = \binom{x}{y} p^y q^{x-y} , \quad y=0,1,2, \dots ,x. \tag{4}$$

Hence, the joint distribution of the number of aircraft collisions with birds X and the corresponding number of damage cases Y has probability function

$$f(x,y) = f(y;x)f_1(x) = e^{-\beta_1}\beta_1^x p^y q^{x-y}/(y!(x-y)!),$$
$$x=0,1,2, \dots , \quad y=0,1,2, \dots ,x. \tag{5}$$

From the joint probability function given in (5) two other probability functions of interest may now be derived. The first of these is $f_2(y)$, the marginal probability function of the number of damage cases, given by

$$f_2(y) = \sum_{x=y}^{\infty} f(x,y) = \frac{p^y e^{-\beta_1}}{y!} \sum_{x=y}^{\infty} \frac{\beta_1^x q^{x-y}}{(x-y)!} \tag{6}$$

Upon setting v=x-y, $f_2(y)$ becomes

$$f_2(y) = \frac{p^y e^{-\beta_1}}{y!} \sum_{v=0}^{\infty} \frac{\beta_1^{v+y} q^v}{v!} \tag{7}$$

since $y \leq x$. And hence, it is readily seen that

$$f_2(y) = \frac{e^{-(\beta_1 p)}(\beta_1 p)^y}{y!} , \quad y=0,1,2, \dots \tag{8}$$

which is the probability function of a Poisson random variable with parameter $\beta_1 p$. The conditional density function of X given Y=y can be found from (5) and (8) to be

$$f(x;y) = f(x,y)/f_2(y) = \frac{e^{-(\beta_1 q)}(\beta_1 q)^{x-y}}{(x-y)!} , \quad x \geq y, \tag{9}$$

which is the probability function of a Poisson random variable with parameter $\beta_1 q$ which has been translated y units to the right.

2.1 Maximum Likelihood Estimation of the Parameters β_1 and p

Given a bivariate sample $\{(x_j,y_j)\}$, $j=1,2, \dots ,n$ from a Poisson-Bernoulli distribution where x_j is the number of aircraft collisions with birds in the jth time interval and y_j is the number of damage cases of aircraft among the x_j birdstrikes in the jth time interval, the likelihood function L is given by

$$L = \prod_{j=1}^{n} \frac{p^{x_j}(1-p)^{x_j-y_j}e^{-\beta_1}\beta_1^{x_j}}{y_j!(x_j-y_j)!} \tag{10}$$

Upon taking the natural logarithm of L, the log-likelihood function is

$$\ln L = (\ln p) \sum_{j=1}^{n} x_j + \ln(1-p) \sum_{j=1}^{n} (x_j-y_j) - n\beta_1 + (\ln \beta_1) \sum_{j=1}^{n} x_j - \sum_{j=1}^{n} \ln y_j! - \sum_{j=1}^{n} \ln(x_j-y_j)! \,. \tag{11}$$

Differentiating (11) with respect to p gives

$$\frac{\partial \ln L}{\partial p} = \frac{\sum_{j=1}^{n} y_j}{p} - \frac{\sum_{j=1}^{n} (x_j-y_j)}{1-p} \tag{12}$$

and differentiation of (11) with respect to β_1 gives

$$\frac{\partial \ln L}{\partial \beta_1} = -n + \frac{\sum_{j=1}^{n} x_j}{\beta_1} \,. \tag{13}$$

Setting (12) and (13) equal to zero gives rise to the likelihood equations

$$\left.\begin{aligned} \sum_{j=1}^{n} y_j - p \sum_{j=1}^{n} x_j &= 0 \\ n\beta_1 - \sum_{j=1}^{n} x_j &= 0 \end{aligned}\right\} . \tag{14}$$

Solution of (14) gives the maximum likelihood estimators

$$\hat{p} = \sum_{j=1}^{n} y_j \Big/ \sum_{j=1}^{n} x_j \tag{15}$$

and

$$\hat{\beta}_1 = \sum_{j=1}^{n} x_j/n \,. \tag{16}$$

These estimates are identical to those obtained by the method of moments since

$$E(X) = \beta_1 \tag{17}$$

and

$$E(Y) = \beta_1 p. \tag{18}$$

3. THE POISSON-POISSON MODEL

Suppose that the number of aircraft collisions with birds X recorded at a specific location in a given time interval has a Poisson distribution with probability function

$$g_1(x) = e^{-\beta_1}\beta_1^x/x! \ , \ x=0,1,2, \ \ldots \ . \tag{19}$$

Let Z_i be a random variable associated with the losses (expressed in terms of conventional units of the cost) resulting from the ith aircraft collision with birds, and suppose that Z_i has a Poisson distribution with parameter β_2; that is,

$$\Pr(Z_i=k) = e^{-\beta_2}\beta_2^k/k! \ , \ k=0,1,2, \ \ldots \ . \tag{20}$$

Now if the Z_i are assumed to be mutually independent, then the conditional distribution of

$$Z = Z_1+Z_2+ \ \ldots \ +Z_X, \tag{21}$$

the total losses recorded among the X aircraft collisions with birds occurring in the jth time interval, is Poisson with parameter $\beta_2 x$. Thus,

$$g(z;x) = e^{-(\beta_2 x)}(\beta_2 x)^z/z! \ , \ z=0,1,2, \ \ldots \ . \tag{22}$$

Hence, the joint distribution of the number of aircraft collisions with birds X and the corresponding losses Z is given by

$$\begin{aligned} g(x,z) &= g(z;x)g_1(x) = e^{-\beta_1}\beta_1^x e^{-(\beta_2 x)}(\beta_2 x)^z/x!z! \\ &= e^{-(\beta_1+\beta_2 x)}\beta_1^x(\beta_2 x)^z/x!z! \ , \\ &\quad x=0,1,2, \ \ldots \ , \quad z=0,1,2, \ \ldots \ . \end{aligned} \tag{23}$$

Having thus derived the joint distribution $g(x,z)$ of the number of aircraft collisions with birds and the losses in (23), it is desired to find $g_2(z)$, the marginal probability function of the losses, and $g(x;z)$, the conditional probability function of the number of aircraft collisions with birds given the losses. From equation (23), it follows that

$$g_2(z) = \sum_{x=0}^{\infty} g(x,z) = \frac{e^{-\beta_1}\beta_2^z}{z!}\sum_{x=0}^{\infty}\frac{(\beta_1 e^{-\beta_2})^x \, x^z}{x!} = \frac{e^{-(\beta_1-a)}\beta_2^z}{z!}\, m_z(a) \tag{24}$$

where

$$a = \beta_1 e^{-\beta_2} \tag{25}$$

and $m_z(a)$ is the zth crude moment of Poisson distribution with parameter a. This distribution has mean and variance given by

$$E(Z) = \sum_{x=0}^{\infty} \sum_{z=0}^{\infty} z \frac{e^{-\beta_1}\beta_1^x}{x!} \frac{e^{-(\beta_2 x)}(\beta_2 x)^z}{z!} = \sum_{x=0}^{\infty} \beta_2 x \frac{e^{-\beta_1}\beta_1^x}{x!} = \beta_1\beta_2 \tag{26}$$

and

$$\mathrm{Var}(Z) = \sum_{x=0}^{\infty} \sum_{z=0}^{\infty} z^2 \frac{e^{-\beta_1}\beta_1^x}{x!} \frac{e^{-(\beta_2 x)}(\beta_2 x)^z}{z!} - \beta_1^2\beta_2^2$$

$$= \sum_{x=0}^{\infty} ((\beta_2 x)^2 + (\beta_2 x)) \frac{e^{-\beta_1}\beta_1^x}{x!} - \beta_1^2\beta_2^2$$

$$= \beta_2^2(\beta_1^2+\beta_1) + \beta_2\beta_1 - \beta_1^2\beta_2^2 = \beta_1\beta_2(\beta_2+1). \tag{27}$$

The conditional probability function $g(x;z)$ can be obtained from (23) and (24) as

$$g(x;z) = g(x,z)/g_2(z) = \frac{e^{-(\beta_1+\beta_2 x)}\beta_1^x(\beta_2 x)^z/x!z!}{e^{-(\beta_1-a)}\beta_2^z m_z(a)/z!} = \frac{e^{-a}a^x x^z}{x!m_z(a)}. \tag{28}$$

3.1 Maximum Likelihood Estimation of the Parameters β_1 and β_2

Given a bivariate sample $\{(x_j,z_j)\}$, $j=1,2,\ldots,n$, from the Poisson-Poisson distribution, the likelihood function L is written as

$$L = \prod_{j=1}^{n} \frac{e^{-\beta_2 x_j}(\beta_2 x_j)^{x_j} e^{-\beta_1}\beta_1^{x_j}}{x_j!z_j!}. \tag{29}$$

Taking the natural logarithm of L gives

$$\ln L = -\beta_2 \sum_{j=1}^{n} x_j + (\ln \beta_2) \sum_{j=1}^{n} z_j + \sum_{j=1}^{n} z_j(\ln x_j) - n\beta_1$$

$$+(\ln \beta_1) \sum_{j=1}^{n} x_j - \sum_{j=1}^{n} \ln x_j! - \sum_{j=1}^{n} \ln z_j!. \tag{30}$$

Differentiation of (30) gives

$$\frac{\partial \ln L}{\partial \beta_1} = -n + \sum_{j=1}^{n} x_j/\beta_1 \tag{31}$$

and

$$\frac{\partial \ln L}{\partial \beta_2} = -\sum_{j=1}^{n} x_j + \sum_{j=1}^{n} z_j/\beta_2 . \tag{32}$$

Setting the partial derivatives equal to zero gives the likelihood equations

$$\left.\begin{aligned} \sum_{j=1}^{n} x_j - \beta_1 n &= 0 \\ -\beta_2 \sum_{j=1}^{n} x_j - \sum_{j=1}^{n} z_j &= 0 \end{aligned}\right\} \tag{33}$$

Solution of (33) gives the maximum likelihood estimates

$$\hat{\beta}_1 = \sum_{j=1}^{n} x_j/n \tag{34}$$

and

$$\hat{\beta}_2 = \sum_{j=1}^{n} z_j \Big/ \sum_{j=1}^{n} x_j . \tag{35}$$

These estimators are identical to those obtained by the method of moments since

$$E(X) = \beta_1 \tag{36}$$

and

$$E(Z) = \beta_1\beta_2 .$$

4. APPLICATION OF THE MODELS TO BIRDSTRIKE DATA

In the present section, the application of both the Poisson-Bernoulli model of section 2 and the Poisson-Poisson model of section 3 to birdstrike data will be discussed. The source of the data is the airports of Latvian SSR. Applying the maximum likelihood estimates of unknown parameters β_1, β_2 and p, the fit of each model to its respective sample for the 153 days and the year 1983 (May-September) was measured using the chi-square goodness-of-fit criterion

$$X^2 = \sum_{\text{all } x,y} \frac{(\text{observed} - \text{expected})^2}{\text{expected}} . \tag{37}$$

TABLE 1. Observed and fitted distributions for the number of aircraft collisions with birds and the number of damage cases of aircraft. (Estimated Poisson-Bernoulli frequencies appear in parenthesis.)

Estimated values of the Poisson-Bernoulli parameters:

$$\hat{\beta}_1 = 0.856209$$

$$\hat{p} = 0.053435$$

		Number of damage cases of aircraft (Y)		
		0	1	Total
Number of aircraft collisions with birds (X)	0	69 (64.99)	– –	69 (64.99)
	1	48 (52.67)	3 (2.97)	51 (55.64)
	2	21 (21.34)	2 (2.48)	23 (23.82)
	3	5 (5.77)	1 (1.03)	6 (6.8)
	4	3 (1.17)	1 (0.58)	4 (1.75)
	Total	146 (145.94)	7 (7.06)	153 (153.00)

Value of the chi-square test of fit:

$$\chi^2_{PB} = 4.03019 \text{ (6 d.f.)}$$

$$Pr(\chi^2_6 \geq 4.03019) = 0.67.$$

TABLE 2. Observed and fitted distributions for the number of aircraft collisions with birds and the losses which are associated with these collisions and expressed in terms of conventional units of the cost. (Estimated Poisson-Poisson frequencies appear in parenthesis.) .

Estimated values of Poisson-Poisson parameters:

$$\hat{\beta}_1 = 0.856209$$

$$\hat{\beta}_2 = 0.053435$$

		Losses associated with aircraft collisions with birds (Z)			
		0	1	2	Total
Number of aircraft collisions with birds (X)	0	69 (64.99)	– –	– –	69 (64.99)
	1	48 (52.75)	3 (2.82)	0 (0.07)	51 (55.64)
	2	21 (21.41)	2 (2.29)	0 (0.12)	23 (23.82)
	3	5 (5.79)	1 (0.93)	0 (0.08)	6 (6.8)
	4	3 (1.18)	1 (0.25)	0 (0.32)	4 (1.75)

Total	146 (146.12)	7 (6.29)	0 (0.59)	153 (153.00)

Value of the chi-square test of fit:

$X^2_{PP} = 6.47818$ (10 d.f.)

$Pr(X^2_{10} \geq 6.47818) = 0.77.$

It will be seen that the agreement between the observed and expected values in each table is quite good.

Note that the Poisson-Bernoulli model is also an appropriate one for analyzing the joint distribution of the total number of birdstrike mishaps and the number of those associated with low-level routes. Observed distribution of birdstrike mishaps and those associated with low-level routes taken from Short (1982) is given below.

TABLE 3. Observed distribution of birdstrike mishaps and those associated with low-level routes

(j)	Total bird strikes (x_j)	Bird strikes along low-level routes (y_j)
January	34	19
February	37	9
March	83	41
April	105	43
May	96	19
June	45	6
July	49	6
August	68	9
September	82	27
October	134	54
November	71	29
December	42	11

Estimated values of the Poisson-Bernoulli parameters:

$\hat{\beta}_1 = 70.5$

$\hat{p} = 0.322695$.

5. CONCLUSIONS

Using the maximum likelihood estimates of the parameters β_1, β_2 and p derived in sections 2 and 3, both the Poisson-Bernoulli model and the Poisson-Poisson model were fitted to birdstrike data.

The fit of each of these models to its respective samples was measured by the chi-square test. Based on an examination of the results of these tests, it must be concluded that the Poisson-Bernoulli and Poisson-Poisson models are too simple to describe adequately these types of bivariate data. The present approach to the problem of describing the joint distribution of the number of aircraft collisions with birds and the number of damage cases of aircraft, and the joint distribution of the number of aircraft collisions with birds and the losses, which are associated with these collisions and expressed in terms of conventional units of the cost, is straight-forward and quite basic. Since the distributional assumptions are generally accepted ones, it seems that the weakness of these models lies with the assumption of homogeneity of the data. Throughout this discussion, the data have been treated as having come from a single population. One possible approach to this problem would be to consider separate models for data arising from similar situations. Also separation of the data would permit one to evaluate the effect on the parameters β_1, β_2 and p of such factors as location, time of day, or weather conditions.

This paper (which should be regarded as a sequel to the essay (Nechval, 1987)) deals with the bivariate probability models applicable to the analysis of birdstrike statistics in order to indicate potential possibilities for improvements which may as yet not be sufficiently realized by engineers running test programs or by policy makers formulating requirements on airworthiness.

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Military aircraft. Bird strike analysis, 1985-1986

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MILITARY AIRCRAFT BIRDSTRIKE ANALYSIS - 1985/1986

INTRODUCTION

1. According to the recommendations of the 18th meeting of the Bird Strike Committee Europe (BSCE) the military birdstrike analysis was transferred to the German Military Geophysical Office (GMGO). The countries participating at the Analysis Working Group were requested to send the military statistics directly to the GMGO within 6 months, in the same format as currently used. Nevertheless only three countries contributed data for the years 1985-86 the worst result in reporting over all previous years. The following table shows a record of contributions to analyses since 1979:

	79	80	81	83	86	88
Belgian Air Force (BAF)	X	X	-	-	X	X
Royal Danish Air Force (RDAF)	X	X	X	X	X	-
French Air Force (EMAA)	(X)	-	-	-	-	-
German Air Force (GAF)	X	-	X	X	X	X
Royal Netherlands Air Force (RNLAF)	-	-	-	(X)	(X)	(X)
Royal Norwegian Air Force (RNoAF)	X	-	-	-	-	-
Royal Air Force (RAF)	X	X	X	X	X	X
Swedish Air Force (SAF)	X	-	X	X	X	-
United States Air Force (Europe) (USAF(E))	(X)	X	-	-	-	-
Total	6	4	4	4	5	3

2. Those contributions indicated as (X) denote that they were in an unusable format.

3. The small number of contributions, when compared with the number of countries participating in BSCE, may be attributed to the change of the compiler or may once again indicate that the usefulness of this report in its present format is in doubt. The Analysis Working Group has to decide if the military birdstrike analysis can be improved or should be finished.

BIRD SPECIES

4. Analysis of Tables 1 shows that the birds most commonly involved in strikes are Gulls (Laridae), Swallows/Swifts (Hirundinide/Apodidae), Pigeons (Columbidae) and Lapwing. 25 % of the bird remains belong to gulls, and more than 50 % of all birdstrikes with gulls damaged the aircraft. Nearly 20 % of the bird remains could be identified as swallows resp. swifts, but there is a significant difference in damage (swifts 36 %, swallows 12 %). 11 %

of the bird remains are pigeons with 58 % damage to aircraft. The lapwing showed a decline from 7,8 % (1985) to 4,4 % (1986). 35 % of the bird strikes caused by lapwings damaged the aircraft. Among the less common bird species attention should be directed to buzzards and kites (2.8 % of the bird remains, 77 % with damage), falcons (2 % of the bird remains, 41 % with damage), crows (2-3,5 % of the bird remains, 57 % with damage), and the starling (3,3 % of the bird remains, 29 % with damage). Geese and ducks are the most dangerous bird species. Though involved in strikes only with 2 %, they damaged in 90 % of all cases the aircraft. The figures confirm the tendency of previous years that the heavier birds are more likely to cause damage.

PART OF AIRCRAFT STRUCK AND EFFECTS

5. One aircraft was lost in 1985. Beyond that one minor and three slight injuries of flight crews were registered in 1985-86. Among the parts of the aircraft struck, engines showed a significant increase between 1979-82 but this levelled off in 1983 and reduced in 1984. This level could be maintained in 1985-86. The percentage of windscreens struck was in 1984 at its lowest level since 1979. The years 1985-86 showed again a similar level. The most significant increase of strikes concerned wings and air intakes. Since 1983 the number of strikes increased continously from 12.3 % upto 22.8 % (1986). The reported damage of all other birdstrikes is of minor nature. Birdstrikes causing no damage continoued, as in previous years, to be about 60 % of the totals reported.

6. As the percentage of damages to all parts of aircraft struck by unknown bird species is considerably higher than the damage caused by species identified from bird remains the relation of strikes to the weight categories A - D is doublful. As remains of small birds cannot be found in many cases, the actual percentage of these birds involved in strikes will be much higher than illustrated by tables 2 and 3.

7. Parts of aircraft struck and effects are dppending from the type of aircraft and the air currents around. As these details are not reported in tables 2 and 3, the significance of the two tables is relatively small with regard to constructive measures.

TABLE 1 - BIRD SPECIES

Military

1985

COMMON NAME	LATIN NAME	AVERAGE WEIGHT	CATEGORY	STRIKES (DAMAGE)	% BASED ON 547
Gull (Various)	Laridae	120-1690	B	91 (51)	16,6
Swift	Apus apus	41	A	63 (25)	11,5
Pigeons (Various)	Columbidae	40-465	A/B	45 (31)	8,2
Lapwing	Vanellus vanellus	215	B	43 (13)	7,8
Swallow/Martin	Hirundinidae	13-19	A	29 (4)	5,3
Skylark	Alauda arvensis	39	A	24 (2)	4,3
Common Gull	Larus canus	420	B	20 (8)	3,6
Starling	Sturnis vulgaris	80	A	19 (7)	3,4
Passeriformes	-	6-1105	A/B	17 (5)	3,1
Black-headed Gull	Larus ridibundus	275	B	16 (5)	2,9
House Martin	Delichon urbica	17	A	15 (2)	2,7
Herring Gull	Larus argentatus	1020	B	12 (10)	2,2
Chaffinch	Fringilla coelebs	23	A	11 (1)	2,0
Buzzard	Buteo buteo	800	B	9 (9)	1,6
Feral Pigeon	Columba livia var	393	B	9 (3)	1,6
Thrush	Turdidae	67-131	A/B	9 (1)	1,6
Crow (Various)	Corvidae	234-1105	B	8 (6)	1,4
Kestrel	Falco tinnunculus	204	B	8 (2)	1,4
Song Thrush	Turdus philomelos	73	A	8 (1)	1,4
Woodpigeon	Columba palumbus	465	B	7 (3)	1,2
Buzzard (Various)	Buteo sp	785-1350	B	7 (3)	1,2
Partridge	Perdix perdix	400	B	5 (2)	0,9
Sparrow	Passer sp	20-32	A	5 (1)	0,9
Sparrowhawk	Accipiter nisus	190	B	4 (0)	0,7
Black Kite	Milvus migrans	780	B	3 (3)	0,5
Kite	Milvus sp	240-1020	B	3 (2)	0,5
Rook	Corvus frugilegus	430	B	3 (2)	0,5
Duck	Anatidae	324-2040	B/C	3 (2)	0,5
Oystercatcher	Haematopus ostralegus	500	B	3 (1)	0,5
Pheasant	Phasianus colchicus	1100	B	3 (0)	0,5
Blackbird	Turdus merula	106	A	3 (0)	0,5
Yellowhammer	Emberiza citrinella	27	A	3 (0)	0,5
Pied Wagtail	Motacilla alba	23	A	3 (0)	0,5
Swallow	Hirundo rustica	19	A	3 (0)	0,5
Finch (Various)	Fringillidae	20-30	A	3 (0)	0,5
Goose	Anser sp.	1300-3600	B-D	2 (2)	0,4
Mallard	Anas platyrhynchos	1080	B	2 (1)	0,4
Snipe	Gallinago gallinago	125	B	2 (0)	0,4
Cattle Egret	Bubulcus ibis	345	B	1 (1)	0,2
Upland Goose	Chloephaga picta	4000	D	1 (1)	0,2
Shelduck	Tadorna tadorna	1080	B	1 (1)	0,2
Hobby	Falco subbuteo	200	B	1 (1)	0,2
Falcon	Falconidae	105-1300	A/B	1 (1)	0,2
Golden Plover	Pluvialis apricaria	185	B	1 (1)	0,2
Wader	-	22-770	A/B	1 (1)	0,2
Stock Dove	Columba oenas	345	B	1 (1)	0,2
G-spotted Woodpecker	Dendrocopus major	80	A	1 (1)	0,2
House Sparrow	Passer domesticus	18	A	1 (1)	0,2

Military

1985

TABLE 1 - BIRD SPECIES (cont'd)

COMMON NAME	LATIN NAME	AVERAGE WEIGHT	CATEGORY	STRIKES (DAMAGE)	% BASED ON 547.
Tufted Duck	Aythya fuligula	740	B	1 (0)	0,2
Hawk	Accipitridae	150-1026	B	1 (0)	0,2
Curlew	Numenius arquata	770	B	1 (0)	0,2
Redshank	Tringa totanus	130	B	1 (0)	0,2
Sanderling	Calidris alba	57	B	1 (0)	0,2
Dunlin	Calidris alpina	50	A	1 (0)	0,2
Lesser B-backed Gull	Larus fuscus	1080	B	1 (1)	0,2
L-eared Owl	Asio otus	273	B	1 (0)	0,2
Tawny Owl	Strix aluco	480	B	1 (0)	0,2
Carrion Crow	Corvus corone	530	B	1 (0)	0,2
Redwing	Turdus iliacus	67	A	1 (0)	0,2
Meadow Pipit	Anthus pratensis	18	A	1 (0)	0,2
Willow Warbler	Phylloscopus trochilus	10	A	1 (0)	0,2
Gold Finch	Carduelis carduelis	16	A	1 (0)	0,2

Notes:

1.1 Bird weight and Latin names can be obtained from Average Bird Weights by T. Brough, July 1983. Unless there is positive evidence to the contrary, the AVERAGE weight should be assumed.

1.2 The bird Categories based on current Civil Airworthiness requirements are:-
CAT A below .11 kg ($\frac{1}{4}$ lb)

CAT B .11 kg to 1.81 kg ($\frac{1}{4}$ lb)

CAT C over 1.81 kg to 3.63 kg (4 lb to 8 lb)

CAT D over 3.63 kg (8 lb)

1.3 Those birds not positively identified should be tabled as unknown.

1.4 Large (CAT C or D) birds are often not positively identified, but the Category these are assumed to be in should be stated.

1.5 Percentages should be based on the total of identified birds.

Military

TABLE 1 - BIRD SPECIES

1986

COMMON NAME	LATIN NAME	AVERAGE WEIGHT	CATEGORY	STRIKES (DAMAGE)	% BASED ON 458
Gull (Various)	Laridae	120-1690	B	82 (50)	17,9
Swift	Apus Apus	41	A	54 (17)	11,8
Pigeons (Various)	Columbidae	40-465	A/B	36 (21)	7,9
Swallow/Martin	Hirundinidae	13-19	A	30 (4)	6,5
Passeriformes	-	6-1105	A/B	22 (7)	4,8
Lapwing	Vanellus vanellus	215	B	20 (9)	4,4
Herring Gull	Larus argentatus	1020	B	16 (11)	3,5
Black-headed Gull	Larus ridibundus	275	B	15 (4)	3,3
Starling	Sturnus vulgaris	80	A	15 (3)	3,3
Skylark	Alauda arvensis	39	A	14 (1)	3,1
Crow (Various)	Corvidae	234-1105	B	11 (7)	2,4
House Martin	Delichon urbica	17	A	10 (1)	2,2
Feral Pigeon	Columba livia var	393	B	9 (4)	2,0
Chaffinch	Fringilla colebs	23	A	9 (0)	2,0
Common Gull	Larus canus	420	B	8 (3)	1,7
Kestrel	Falco tinnunculus	204	B	8 (3)	1,7
Buzzard	Buteo buteo	800	B	7 (6)	1,5
Oystercatcher	Haematopus ostralegus	500	B	7 (2)	1,5
Swallow	Hirundo rustica	19	A	7 (0)	1,5
Buzzard (Various)	Buteo sp	785-1350	B	6 (5)	1,3
Woodpigeon	Columba palumbus	465	B	6 (3)	1,3
Duck	Anatidae	324-2040	B/C	5 (5)	1,1
Rook	Corvus frugilegus	430	B	5 (1)	1,1
Thrush	Turdidae	67-131	A/B	5 (1)	1,1
Golden Plover	Pluvialis apricaria	185	B	4 (3)	0,9
Falcon	Falconidae	105-1300	A/B	4 (2)	0,9
Reed Bunting	Emberiza schoeniclus	20	A	4 (1)	0,9
Goose	Anser sp	1300-3600	B-D	3 (3)	0,7
Mallard	Anas platyrhynchos	1080	B	3 (3)	0,7
Partridge	Perdix perdix	400	B	3 (1)	0,7
Song Thrush	Turdus philomelos	73	A	3 (1)	0,7
Yellowhammer	Emberiza citrinella	27	A	3 (1)	0,7
Tree Sparrow	Passer montanus	20	A	3 (0)	0,7
Pheasant	Phasianus colchicus	1100	B	2 (0)	0,4
Blackbird	Turdus merula	106	A	2 (0)	0,4
Meadow Pipit	Anthus pratensis	18	A	2 (0)	0,4
Sparrow	Passer sp	20-32	A	2 (0)	0,4
Greylag Goose	Anser anser	3325	C	1 (1)	0,2
Gannet	Sula bassana	2900	C	1 (1)	0,2
Stork	Ciconia ciconia	3400	C	1 (0)	0,2
Linnet	Carduelis cannabina	19	A	1 (0)	0,2
Lesser B-backed Gull	Larus fuscus	820	B	1 (0)	0,2
Grey Plover	Pluvialis squatarola	200	B	1 (0)	0,2
Snipe	Gallinago gallinago	125	B	1 (0)	0,2
Fieldfare	Turdus pilaris	99	A	1 (0)	0,2
Black Redstart	Phoenicurus ochruros	16	A	1 (0)	0,2
Great Tit	Parus major	19	A	1 (0)	0,2
Corn Bunting	Emberiza calandra	48	A	1 (0)	0,2
Sparrowhawk	Accipiter nisus	190	B	1 (0)	0,2
House Sparrow	Passer domesticus	18	A	1 (0)	0,2

TABLE 2 PART OF AIRCRAFT STRUCK

PART	WEIGHT UNKNOWN	CAT A	CAT B	CAT C & D	TOTAL	% BASED ON 1866
Nose (excluding radome and windscreen)	147	45	69	-	261	14,0
Radome	83	11	28	-	122	6,5
Windscreen	209	62	40	-	311	16,7
Fuselage (excluding the above)	109	22	58	-	189	10,1
Engine:-						
1 engine struck	157	60	101	-	318	17,0
2 out of 3 struck	-	-	-	-	0	0
2 out of 4 struck	1	1	-	-	2	0,1
3 out of 4 struck	-	-	-	-	0	0
all struck (on multi-engined aircraft)	1	1	2	-	4	0,2
Wing + Air Intakes	244	50	89	1	384	20,6
Rotor/Propeller	11	16	28	-	55	3,0
Landing Gear	19	11	23	-	53	2,8
Empennage	27	-	13	-	40	2,1
Underwing Stores/Tanks	68	4	26	-	98	5,3
Part Unknown	18	5	6	-	29	1,6
Total	1094	288	483	1	1866	100

Notes:

2.1 The Total in Table 2 and 3 may be higher than other tables, as one bird can strike several parts.

2.2 The percentages should be based on incidents where the part struck is known.

2.3 Multiple strikes should be counted as one strike, unless for example both wings or both landing gears are struck, when two incidents should be recorded.

MILITARY

TABLE 2 PART OF AIRCRAFT STRUCK

1986

Part	WEIGHT UNKNOWN	CAT A	CAT B	CAT C & D	TOTAL	% BASED ON 1372
Nose (excluding radome and windscreen)	95	34	42	1	172	12,5
Radome	64	8	21	1	94	6,9
Windscreen	140	30	26	-	196	14,3
Fuselage (excluding the above)	89	25	44	-	158	11,5
Engine: -						
1 engine struck	107	27	63	-	197	14,4
2 out of 3 struck	-	-	-	-	0	0
2 out of 4 struck	-	-	1	-	1	0,1
3 out of 4 struck	-	-	-	-	0	0
all struck (on multi-engined aircraft)	2	-	3	-	5	0,4
Wing + Air Intakes	187	31	93	2	313	22,8
Rotor/Propeller	14	7	15	-	36	2,6
Landing Gear	22	6	19	-	47	3,4
Empennage	20	5	14	-	39	2,8
Underwing Stores/Tanks	54	-	13	-	67	4,9
Part Unknown	28	11	8	-	47	3,4
Total	822	184	362	4	1372	100

Notes:

2.1 The Total in Table 2 and 3 may be higher than other tables, as one bird can strike several parts.

2.2 The percentages should be based on incidents where the part struck is known.

2.3 Multiple strikes should be counted as one strike, unless for example both wings or both landing gears are struck, when two incidents should be recorded.

TABLE 3 EFFECT OF STRIKE

1985

EFFECT	WEIGHT UNKNOWN	CAT. A	CAT B	CAT C	CAT D	TOTAL	% BASED ON 1357
Loss of Life/Aircraft	-	-	1	-	-	1	0,1
Flight Crew Injury							
Major	-	-	-	-	-	0	0
Minor	-	-	-	-	-	0	0
Slight	-	-	2	-	-	2	0,1
Engine damage requiring repair:-							
on single engined aircraft	16	11	23	-	-	50	3,6
1 on a 2 engined aircraft	29	7	29	-	-	65	4,7
2 " 3 " "	-	-	-	-	-	0	0
1 " 4 " "	2	1	4	-	-	7	0,5
2 " 3 " "	-	-	-	-	-	0	0
2 " 4 " "	-	-	-	-	-	0	0
3 " 4 " "	-	-	-	-	-	0	0
all engines on a multi	-	-	-	-	-	0	0
Windscreen Cracked/Broken	13	3	10	-	-	26	1,9
Radome Changed	14	-	12	-	-	26	1,9
Deformed Structure	42	2	44	-	-	88	6,4
Skin Torn	46	4	24	-	-	74	5,4
Skin Dented	79	12	35	1	.	127	9,3
Propeller/Rotor Demaged	-	-	4	-	-	4	0,3
Aircraft System Lost	1	-	2	-	-	3	0,2
Underwing Stores/Tanks damaged	35	1	18	-	-	54	3,9
Miscellaneous	9	3	6	-	-	18	1,3
Nil Damage	506	158	159	-	1	824	60,6
Unknown	7	-	5	-	-	12	-
TOTAL	799	202	378	1	1	1381	100,2

Notes:-

3.1 Multiple strikes should be counted as one strike, unless for example both wings are damaged, or both windscreens are broken, in which case two incidents should be recorded.

3.2 Definition of Injury requiring medical treatment:
Major - causing absence of 21 days or over
Minor - causing absence of 7 to 21 days
Slight - injury not in above 2 categories.

3.3 Injuries as a consequence of a strike, e.g. ejection injuries should be included

3.4 Aircraft system lost includes for example electrical, hydraulic, brake, air conditioning, de-icing.

Military

TABLE 3 EFFECT OF STRIKE 1986

EFFECT	WEIGHT UNKNOWN	CAT A	CAT B	CAT C	CAT D	TOTAL	% BASED ON 1225
Loss of Life/Aircraft	-	-	-	-	-	0	0
Flight Crew Injury							
Major	-	-	-	-	-	0	0
Minor	-	-	1	-	-	1	0,1
Slight	1	-	-	-	-	1	0,1
Engine damage requiring repair:-							
on single engined aircraft	24	7	16	-	-	47	3,8
1 on a 2 " "	20	4	19	3	-	46	3,7
1 " 3 " "	-	-	-	-	-	0	0
1 " 4 " "	-	-	1	-	-	1	0,1
2 " 3 " "	-	-	-	-	-	0	0
2 " 4 " "	-	-	-	-	-	0	0
3 " 4 " "	-	-	-	-	-	0	0
all engines on a multi	-	-	1	-	-	1	0,1
Windscreen Cracked/Broken	19	-	9	-	-	28	2,3
Radome Changed	12	-	8	-	-	20	1,6
Deformed Structure	21	2	23	1	-	47	3,8
Skin Torn/light glass broken	36	2	25	4	-	67	5,5
Skin Dented	101	12	39	2	-	154	12,6
Propeller/Rotor Damaged	1	-	2	-	-	3	0,2
Aircraft System Lost	2	-	4	1	-	7	0,6
Underwing Stores/Tanks damaged	21	1	7	-	-	29	2,4
Miscellaneous	5	-	-	-	-	5	0,4
Nil Damage	496	142	129	1	-	768	62,7
Unknown	-	-	-	-	-	-	-
TOTAL	759	170	284	12	-	1225	100

Notes:

3.1 Multiple strikes should be counted as one strike, unless for example both wings are damaged, or both windcreens are broken, in which case two incidents should be recorded.

3.2 Definition of Injury requiring medical treatment:
Major - causing absence of 21 days or over
Minor - " " of 7 to 21 days
Slight - injury not in above 2 categories.

3.3 Injuries as a consequence of a strike, e.g. ejection injuries should be included

3.4 Aircraft system lost includes for example electrical, hydraulic, brake, air conditioning, de-icing.

ADF616003

Measures to minimize bird hazard at low level

(J. Becker, Germany)

Summary

The Bird Movement Working Group (BMWG) shall develop preventive measures to minimize the bird hazard to low flying aircraft.

A survey of the existing procedures for military low level flights was given during two meetings "Bird Hazard at Low Level". The participants emphasized the necessity of regular radar observations, standardized birdstrike warnings (BIRDTAM) as well as standing procedures for the flying units. They recommended the improvement and standardization of the existing procedures, and the distribution of all information concerning large-scale bird movements of medium and high intensities beyond national borders.

1. Introduction

According to the recommendations of BSCE 18, Copenhagen, the Bird Movement Working Group (BMWG) shall develop preventive measures to minimize the bird hazard to low flying aircraft. During two meetings "Bird Hazard at Low Level" held at the German Military Geophysical Office (GMGO), Traben-Trarbach/FRG, November 24-26, 1986, and September 09-11,1987 participants from Belgian Air Force (BAF), Canadian Forces in Europe (CFE), German Air Force (GAF), Royal Air Force in Germany (RAFG), Royal Netherlands Air Force (RNLAF), and United States Air Force in Europe (USAFE) discussed the existing procedures, and emphasized the significance of standardized observations and warnings with regard to permanent and temporary bird concentrations.

2. Information available on bird concentrations and bird movements

Bird concentration areas with high numbers of breeding, resting or wintering species are generally well known and specified in bird hazard maps based on the results of the BMWG. The maps are published in the national AIPs, and pilots are strongly advised not to cross these areas below 1000 ft AGL. A first attempt of standardization was the map "Birdstrike Danger Areas Europe" issued by the GMGO in 1979, but the size and the colour of the different areas could not be completely standardized with regard to the average number of birds due to the lack of detailed information for all countries.

When on actual migration, most birds cross large areas at flight levels between 500 and 4000 ft AGL in contrast to their flying at relatively low altitudes during their stay in the concentration areas. According to radar observations bird migration often occurs over a broad front, covering thousands of square kilometers. The birdstrike hazard caused by these large-scale bird movements cannot be described point-like, because it is advancing with the "wave" of migrating birds. This kind of migration gives rise to a temporary birdstrike risk, and can only be detected by a sophisticated observation network.

Continous observations of migrating birds by radar are performed in Denmark, Belgium, The Netherlands, and West Germany. They use different techniques for the identification of bird movements:

- in Denmark 1 radar station is using an electronic countig system for bird echoes ("FAUST"-system). The separation of bird echoes and clutter is imperfect, and the system does not give height information, (see BSCE 8/WP 8-2).

- in Belgium 1 radar station is using an advanced electronic counting system for bird echoes ("BOSS"-system). This system uses an improved altitude discrimination with 4 height layers, and electronic determination of echo strength and density (see BSCE 18/WP 16).

  A 2nd radar station is still using polaroid pictures of the radar screen for the identification of bird movements.

- in The Netherlands 1 radar station is observing bird migratory movements by a sophisticated electronic counting system ("KIEVIT") using the two lowest beams of a 3 D-radar. Clutter and bird echoes are discriminated by two seperate thresholds. However, due to the filter process many birds may eleminate each other when the echo density is too high; Therefore, the system still needs an experienced person to evaluate the figures. In the near future the identification and discrimination of bird echoes will be further improved by a new computer analyses ("ROBIN"-system).

- in the Federal Republic of Germany 10 radar stations are still using the photographic system for the identification of bird movements (see BSCE 18/WP 5). Disadvantages of the photographic system are a loss of information in the video processing as well as the identification and determination of bird echoes by different persons. With regard to the new HADR-System the possibility of a computerized clutter analysis will be tested in the future.

Supplementary information concerning bird migration can be obtained by GCA- and Wx-radar equipments as well as pilot reports and visual observations on aerodromes, but the identification of bird echoes respectively the calibration of bird hazard intensities are relatively difficult.

RAFG can detect medium to heavy bird movements by the AR 1 Search Radar at altitudes below 1000 ft AGL. Similar observations might be possible on CFE and USAFE aerodromes if a suitable guidance with typical pictures of different bird intensities will be existing.

Weather radars are generally suitable for the detection of bird movements. Good results have been reported from Sweden (see BSCE 11/WP 7) an the USA (see BSCE 18/WP 7). The Weather radar METEOR 200 needs a photographic equipment for the identification of bird echoes. The new US weather radar "NEXRAD" would solve many problems of bird detection and identification. The system can distinguish the different classes of targets and can distinguish birds from weather. Ultimately this system will provide real-time bird hazard warning information on a continent-wide scale.

The visual observation of bird migration is very limited. It is depending on the size, colour and motion of the birds, the contrast to the background, and the visibility. An exact correlation between the number of birds observed and the intensity according to the 0-8 scale is not possible. In Germany visual observations complete the radar network in areas and times without radar observation of birds, but the intensities of bird migration based on visual observations are always roughly estimated.

The calibration and standardization of bird intensities obtained by different types of radar, and by different techniques of identification make the basis of standardized warnings. Exact measurements of bird intensities are still missing.

3. The content and format of birdstrike warnings

Birdstrike warnings should include all information important to safe flight performances, but no information demanding interpretations or transformations to the pilot. The content and format of these warnings determine the liability of the warning. For this reason a format similar

to NOTAM is very suitable, even if there are no specific ICAO regulations existing for birdstrike warnings. Meanwhile the ICAO considered a requirement for the introduction of a specific message relating to bird concentrations, possibly a form of NOTAM or BIRDTAM with the abbreviation BIR as a prefix for such messages.

The data important to pilots are specified as follows:

- areas should be well defined by use of GEOREF indicator or geographic coordinates and range,
- bird intensity according to the international 0 to 8 scale, because flight restrictions are depending on bird movement intensities,
- altitudes including the lower and upper limits of birdstrike danger with regard to the bird movement intensity indicated,
- validity as a well defined period between 2 and 4 hrs.

If countries are not able to collect and disseminate all information required they may limit the content of the message to those items known by the issuing station.

In the past the different national formats of birdstrike warnings/birdtam/ bird risk warnings/bird migration warnings had differed strongly from each other. Therefore the NATO standardization agreement STANAG 3879 FS had been drawn up with the aim to standardize the procedures for the exchange of information on birdstrike warning to enable operational commanders to reduce the risk of birdstrikes.

Birdstrike warnings will be sent by telex (BFSTA/AFTN) using a format similar to the ICAO format of NOTAM Class I whenever a bird intensity of 5 and greater is present.

According to the proposal of the ICAO an easy recognisable name for the birdstrike warning should be chosen. The well-known name "BIRDTAM" was generally approved by the participants of the meetings as a most clearcut indicator.

Birdstrike warnings/BIRDTAM are regularly issued by Belgium, Denmark, Germany and The Netherlands. CFE, RAFG and USAFE use the warnings as well for operational purpose.

4. Flight restrictions by birdstrike warnings

As a jet aircraft has a mean speed of 200 m/sec it is nearly impossible for the pilot to avoid a collision if the bird is flying directly in front of him. Therefore flight restrictions are the only possibility to reduce the number of birdstrikes over areas covered by dense bird migration indicated by birdtam.

For the Belgian Air Force (BAF) flight restrictions to jet aircraft are in force if a bird intensity of 5 and greater is present. Flight performances are allowed from 1000 ft above the upper altitude limit and 1000 ft below the lower limit respectively above 500(ft AGL, if no altitude has been specified. Gunnery ranges are closed at an intensity of 5 or greater.

The German Air Force (GAF) has the following regulations:

- areas with bird intensities 6-8 are completely restricted to jet aircraft.
- areas with bird intensities 4-5 are restricted to jet aircraft except national and NATO exercises as well as take off/landing/touch and go approaches if ATC does not observe any birds. The approach to gunnery ranges is permitted if the bird activity is low over the range area.

For the Royal Air Force in Germany (RAFG) areas with bird intensities 6-8 are completely closed to jet aircraft. At intensity 5 some advisory regulations are existing. Low level flights are also prohibited within 5 NM either side of the coastline and over areas with moderate to high or high birdstrike risk. Beyond that advisory regulations are existing that low flying during 2 hours after sunrise and 1 hour either side of sunset should be avoided.

The Royal Netherlands Air Force (RNLAF) has flight restrictions to jet aircraft at bird intensities 7-8 and advisory regulations at intensities 5-6 northwest of a line Boulogne - Venlo - Hannover - Hamburg. Regulations concerning the flyways through the Wadden Sea are in preparation. The speed of helicopters flying below 600 ft AGL should not exceed 80 kts, if flight restrictions to jet aircraft are in force.

The Canadian Forces in Europe (CFE) restrict low level flying at bird intensities of 5 and greater. The USAFE has no general regulations concerning birdstrike warnings. Flight restrictions in case of high bird activity in certain areas are left to the individual base or local command.

If birdstrike warnings/birdtam are valid before take-off pilots must change in advance their flight schedule to avoid the areas and altitudes with high birdstrike risk. If pilots are just enroute the fixer frequencies can be used for the transmission of warnings, but blocking of the frequency by too many messages must be avoided.

The reduction of speed when there is evidence of a higher than normal birdstrike risk can reduce the impact force of a birdstrike. However, the effect is relatively small, for the minimum speed commensurate with safe operation of the aircraft must be taken into consideration.

4. Recommendations

1. The Bird Movement Working Group (BMWG) has two objectives:
   - knowledge of the flying behaviour of birds in the vicinity of aerodromes/airfields
   - procedures of birdstrike prevention for aircraft flying at low level.

   The fundamental aspects of radarornithology and remote sensing should be left to the Radar Working Group. The operational aspects should be subject of the BMWG.

2. The calibration and standardization of bird intensities obtained by radar are the basis of standardized warnings. An exchange of radar data should start between the radar stations of Belgium. The Netherlands and NW-Germany. As a second step computer programs for counting birds should be standardized.

3. The existing radar observation network should be extended to GCA-radar (ASR and PAR) whenever possible. For this purpose it must be tested whether the ATC-radar can detect and, in conjunction with PAR-system, determine the height of bird activities. A standard observation and reporting system must be developed that will enable the radar controllers to determine bird intensities and altitudes. Bird observation messages should include date and time of the observation, an estimation of the bird intensity (medium/high) and if possible the altitude of bird migration.

4. The new US weather radar "NEXRAD" should be brought to an operational use also for the observation of bird movements. As soon as NEXRAD will be established at US bases in Germany regulations for the observation of bird movements should be developed.

5. For birdstrike warnings the name "BIRDTAM" should be used by all countries in accordance to the requirement of the Air Navigation Commission of the ICAO. The Military Agency for Standardization (MAS) should also agree to the name "BIRDTAM" in the STANAG 3879 FS.

6. The existing bird hazard maps should be improved with regard to recent knowledge concerning the average numbers of birds in different areas. A periodically updating of the maps will be necessary. More emphasis should be focussed to local bird movements in any way (esp.airfield vicinity maps).

7. Air traffic authorities, flying units, and radar personnel need more information concerning the extent and the fluctuation of the birdstrike risk. They should be convinced by movies and video tapes illustrating the birdstrike hazard in relation to migratory movements of birds.

8. As borders do not stop the bird migration, all countries participating at the meetings of the BSCE are requested to exchange actual data concerning medium and high intensities of bird migration as well as birdstrike warnings (BIRDTAM) in a standardized format via the civil and military ATC-networks.

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Spanish birds and their influence on flight and mission planning

(M.ª Jesús Vicente y Clemente Ros, Madrid)

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SPANISH BIRDS AND THEIR INFLUENCE ON FLIGHT AND MISSION PLANNING

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SUMMARY

This paper presents some ideas for hazard level comparition between the different bird species.

It addresses resident Spanish birds, especially vultures (*Gyps fulvus*) and similar ones.

Later some facts about Spanish migratory movements and their relationship to weather conditions, isophenic lines, and the most dangerous season time are presented.

Finally, the paper gives, conclusions about strike avoidance and some proposals.

This work is dedicated to Mr. Mariano Vicente Jordana, meteorologist whom after 38 years of working in Meteorological Applications to Defense, encouraged us to finish it.

The authors.

1.- INTRODUCTION.

The goal of this work is to present some new ideas to improve one's knowledge of the Spanish bird fauna, primarily in the areas concerning detection and control.

Obtaining more information and knowledge is the only way to avoid - at least partially - the bird hazard on general aviation flights and especially during low level, high speed military flights.

Explanations concerning bird control near bases and airports will be omitted in this report. The only program to be mentioned will be the highly effective system of falconry near airport runways. This program whose best example was the (*1) "Bahari Operation" began in August 1968, under the direction of Dr. Felix Rodriguez de la Fuente. It was developed at the request of then Capt. José Sanchez Mendez, and is still providing excelent results at Torrejón Air Base and Madrid Barajas Airport. The successful falconry program at Moron Air Base, lead by Mr. Jesús Brizuela Martínez, must also be mentioned.

Other methods such as poisoning, ditress sounds, explotions, hunting, etc. have been shown to be less effective, and in some cases very dangerous. One such case occurred in 1966 when a very high number of sisones (*Tetrax tetrax*) at Torrejón A.B., forced the Flight Safety Officers -USAF and SAF (*2)- to try to frighten them off by using an M-79 grenade-launcher. After the first test they decided to abandon the method since the shrapnel fragments presented more danger than did the birds.

Falconry is seen as an elegant, effective, and inexpensive method that must be used in conjuntion with other non-destructive methods to realize total erradication of birds near terminal areas and runways.

(*1) Bahari is a kind of falcon
(*2) SAF = Spanish Air Force

This work doesn't deal with the bird hazard in the air terminal area -a topic has been thoroughly covered in similar works- but deals with the hazard birds present enroute. To reach this objetive, the first step must be to classify the different known species by their hazard level. Later we will talk about both, sedentary and migratory species and in the last portion will present some conclusions and proposals.

2.- POTENTIAL HAZARD CLASSIFFICATION

The first step in studying bird hazards is to classify the better known species by order of their potential risk to the pilot. We propose an empirical mathematic formula which can help us determine this potential.

In the first step we will treat the birds as if they were rigid airplanes. Nothing could be further from the truth, but this will allow us to study the birds through the application of some aerodynamic formulas. We will omit a lot of factors that affect the hazard level, such as flying muscle strength, speed of reflex action, changes in wing geometry, etc., because they are difficult to measure.

In spite of this we will continue with the next step. We can define the potential danger of a flock of birds with the following equation:

$$P = \phi\left(W,\ Vr,\ \frac{1}{p},\ \frac{1}{n},\ De.\right)$$

In which the potential danger (P), varies directly to weight (W), relative speed (Vr), spatial density (De); and varies inversely to banking speed (p), and load factor (n) better known as the "G pulling" capability.

We know through aerodynamics that

$$p = \frac{2\ V\ \ K_1}{b} \quad ; \quad \text{and} \quad n = \frac{K_2}{W/S}$$

where (V) is the bird cruising speed, (b) is its wingspan, (W/S) is the wing load factor, (K) and (K) are constants that depend basicly on the wing shape and for our purposes will be considered to be the same for all bird species.

We will define spatial density of a flock (De) as the number of birds that would hit the aircraft as it passed through the flock. We will represent with the following:

$$De = \frac{N}{St \cdot L}$$

(N) is the number of birds in the flock, (St) is the maximum cross section of the aircraft , (L) is the length of the flock measured in the direction of the Vr vector (aircraft path).

The Vr factor is squared due to the quadratic influence than the speed has on the kinetic energy.

$$Ec = \frac{1}{2} \ m \ V^2$$

Only the aircraft can exercise maneuverability, because we assume -with wisdom- that the bird cannot outfly the approaching aircraft in the direction of the aircraft's path.

We square the rolling capabilty (p) and the load factor (n) because those factors can only move the bird within two dimensional space to avoid strike against the aircraft.

The spatial density (De) has a tri-dementional effect which is the reason we cube it. Therefore,

$$P = W \ Vr^2 \ \frac{b^2}{4 \ V^2 \ K_1^2} \cdot \frac{W^2}{S^2 \ K_2^2} \ De^3 =$$

$$= K_3 \ \frac{W^3 \ Vr^2 \ b^2 \ De^3}{V^2 \ S^2} \ ;$$

Now if we assume that the bird speed (V) is almost constant for a large number of species and that the relative speed (Vr) is almost equal to the aircraft speed, which could easily be 480 knots and which we can consider constant for a large number of aircrafts. then

$$P = K_4 \ \frac{b^2 \ W^3 \ De^3}{S^2}$$

In order to simplify this example, we are going to assume that there is only one bird flying, then (De) will be equal to one (De = 1). On the other hand we know that the wing surface (S) is obtained by multiplying the average aerodynamic cord (c) by the wingspan (b), (S = b c); therefore

$$\boxed{P = K_4 \frac{W^3}{c^2}}$$

This formula -we call Clement's formula- gives us a relative value of the potential hazard of a bird as a function of its weight and average aerodynamic cord. We must enphasize that weight has a great influence on the P value. Applying the formula to the best known species, we can order them from high to low danger as such: common vulture (Gyps fulvus), crane (Grus grus), flamingo (Phoenicopterus ruber), white stork (Ciconia cinonia), goose (Ansarinae), ducks (Anatidae), gulls (Laridae), doves (Culumbidae), and swallows (Hirundinidae).

3.-RESIDENT BIRDS

The vulture (Gyps fulvus) is considered the most dangerous bird to an aircraft, due to its high weight, large size, low reflex action and sluggish maneuverability. Although the vulture is considered a resident (nonmigratory) bird, some experts have found birds in Central Morocco that were banded in Navarra (North of Spain). These are very rare incidents, though, and we consider the vultures resident birds.

Based on the vulture census that was performed in 1979 by the Sociedad Española de Ornitologia (SEO)(Spanish Society of Ornitology) and kindly provided by Mr. Eduardo de Juana, we can make a map like that of FIGURE N°1, in which appears the vultures nesting areas and their zone of influence. It is possible to group these areas into a mountainous terrain system from which we obtain ten vulture groups (see FIGURE N°2). The most important of them are:

N° 1) Pirenaico Group
Located in the Pyrenee of Navarra and Huesca.
Average altitude of the vulture sites 2.900 ft.MSL

(Mean Sea Level). Approximately 700 pairs. May be the most important group due to its proximity to Bardenas Reales air-to-ground range.

N°3) Norteiberico Group

Located in the Rioja region, south of Zaragoza and a section of Soria. Average altitude of the vulture sites is 3.200 ft. MSL. Approximately 300 pairs. Part of this group is close to the Bardenas Reales air- to-ground range. This group includes a portion of D-104 which is a danger area reserved for military air exercises conducted at low level and high speed.

N°4) Subiberico Group

Includes Teruel and zones near Castellón and Tarragona. Average altitude of the vulture sites is 2.900 ft. MSL. Approximately 250 pairs. This group includes most of D-104 and Caude air-to-ground range near Teruel.

N°10) Gaditano Group

Includes Sierra Betica between Ronda and Gibraltar Strait. Average altitud of the vulture sites is 1.400 ft. MSL. This is the most densely populated group in Spain. Approximately 650 pairs.

By looking at FIGURE N°1 and N°2, the pilot can determine which zones he will fly near or through during his mission and can exercise extra caution as necessary.

Due to its large size, a vulture can easily can be detected approximately one half nautical mile (1/2 NM) away. If we are flying 480 knots, this means there are only about four (4) seconds of reaction time. The aircraft should be maneuvered because it is likely that the bird will not notice the aircraft until it has flown past the bird.

To avoid the bird the pilot in most cases, should execute a pull-up, because birds usually execute a dive in order to achieve the maximum acceleration in the minimum amount of time and with the minimum muscular activity.

Knowing the terrain where vultures live is also very helpful in avoiding them. They almost always will be found near their nests in very steep terrain. When a pilot flies near a ridge, he must be especially careful since it is highly probable that a vulture is flying nearby.

On a sunny day with thermal or orographic updrafts one is likely to find soaring vultures. On a windy day it is possible to find birds using the sloping effect of the wind against a mountain to soar. For this reason as well as for other safety reasons, a pilot should always account for the wind strength and direction when flying low level over mountainous terrain.

Only in a day with very good weather conditions and high thermal updrafts is there the possibility of finding vultures and other gliding birds above flat terrain; especially at noon time when the sun is at its maximum thermal activity.

In addition 80% of the vulture couples nest on lime-based rock areas, while other 20% nest on silicon-based rock areas. On the lime-based rock areas we can find vulture colonies of 40 to 100 couples, but in the silicon-based rock we may only find colonies of about 20 couples, (except for the outstanding colonies of the Monfragüe National Park).

In an intuitive way, with the previously mentioned data and with the help of FIGURE N°1 and N°2, it is possible to determine , at a given moment, the zones with the highest probability of finding vultures or other kind of birds.

Of course not in all seemingly ideal nesting terrain will one find vultures, because their presence and nesting are determined by other factors, such as the availability of food, good weather conditions, etc. For example in the Cantabro-galaica zone (north-west Iberian Peninsula), which provides good terrain condition for nesting, there are no nesting vultures due to the high number of cloudy and cold days per year. As well, vultures could possibly nest in the Alicante zone, but there is little food due to the small livestock industry, little hunting, and the lack of artifitial feeding places.

4.-MIGRATORY BIRDS

There are many species of migratory birds which cross Spain the year round. We will consider only those species which present a bird strike hazard.

The bird migration is a very complex phenomenom which is affected by a number of factors such as season, food availability, wind strength and direction, barometric pressure, phenologic plants state, etc,.

The migratory routes aren't as stable nor predictable as one would like. Experts in this field, like Dr. Francisco Bernis (President of the Spanish Ornitology Society and professor of Zoology in the Complutense University), after years of study have reached the conclusion that it is very difficult to predict at what moment the birds will begin their migration and which routes they will use. For this reason we state that the migration routes shown in FIGURES N°3, N°4 and N°5 only indicate the general direction of the migration movements. One exception to this is the crane (*Grus grus*) which every year flies the same route.

We can classify the migratory birds in groups by their migration habits.

Winter birds

These are birds that spend the winter time in Spain. When Spring arrives they leave the Iberian Peninsula with a southwest-northeast (SW-NE) flow, heading to Scandinavia and Central Europe where they normaly make their nests.

When they finish reproducing -in early Fall- they begin migration in a northeast-southwest (NE-SW) flow, escaping the cold weather and looking for more benign and warmer countries such as Spain, where they spend the entire winter. Some winter species and their routes are shown in FIGURE N°3 and N°4. The arrows indicate the inbound direction in Fall; the same routes in the opposite direction are flown outbound from Spain in Spring with (SW-NE) flow.

Summery birds

These are birds that spend the summertime on the Iberian Peninsula where they normally nest. At the end of the summer when they have finished reproducing, they begin migrating south, crossing to Africa almost always by way of the Gibraltar Strait, in order to look for warmer weather in Central and North Africa. When Spring arrives, they escape from the hotter African countries following wide bands flowing more or less south-north (S-N). Upon reaching the Iberian Peninsula, they spread out in a dispersive mode. We call this wide front migration. This migration spreads throughout the entire Spanish territory. These species of migratory birds nest during Spring and early Summer, thus completing the annual cycle. See FIGURE N°5.

Most birds have the migratory habit of not following fixed routes. They migrate in wide front pattern. A tipical example is the swallow (Hirundo rustica). In order to locate this migration in space and time, we use isophenic lines. The lines indicate the points where the same phenomenom takes place simultaneously. In FIGURES N°6 and N°6-A -which was provided by the Instituto Nacional de Meteorología (INM)- we see the isophenic lines of the swallow and white stork arrivals.

Of course there are other migration habits, (partial migrations, accidental migrations, nesting birds, etc,), but we don't deal with them due to their complexity and their lack of data.

There exists a close relationship between the time and intensity of migration movements and the meteorological conditions, especially when one consider strong winds in the direction of migration. Thanks to

the data provided by meteorologist Mr. Lorenzo García Pedraza, we can learn something concrete about this relationship.

In reference to the summer birds, the most intense migration movement (flow S-N) coming from Africa is influenced by a weather condition similar to the one shown in FIGURE N°7 in which the moderate tailwinds -called Lebeche wind- make for an easy crossing of the Gibraltar Strait.

The north-south (N-S) flow, from Spain to Africa is helped by a meteorological condition like the one shown im FIGURE N°8. The birds take advantage of the strong tailwinds -called Tramontana wind- by flying most of the time behind a cold front which is sweeping the Iberian Peninsula from north to south.

Concerning the winter birds, the migratory movement into Spain is helped by the meteorological condition shown in FIGURE Nº9, in which the strong cold winds coming from Central Europe, help the north-east to south-west bird flow. The contrary flow, from south-weast to north-east, is helped by a meteorological condition like the one shown in FIGURE Nº 10, in which the warm south-weast winds help the birds reach Central Europe and Scandinavia.

It is known that migratory movements take place during the entire year, a rather useless conclusion in itself, but in looking at FIGURE Nº 11, we can see that it is possible to identify the seasons with the most migratory activity.

The overlap which exists between winter and summer birds, produces high migratory activity during the entire month of March and the second half October.

5.-CONCLUSIONS:

- The vulture (Gyps fulvus) is considered the most dangerous bird to low level flights.

- The nesting points and vulture colonies are shown in FIGURE Nº 1.

- The most dangerous zones for military low level flights are the nº 1,3,4 and 10 groups (see FIGURE Nº 2).

- During March and April one can expect high migratory activity with a south-west to north-east flow, especially during those days that have meteorological conditions like those shown in FIGURE Nº 10. The most dangerous zone will be the north-east quarter of the Iberian Peninsula, especially the Pyrenees.

- During the second half of October and all of September, one can expect high migratory activity with a north-east to south-west flow, especially on those days that have meteorological conditions like those shown in FIGURE Nº 9; the Pyrenees zone will again be the most dangerous.

- During February and March the migratory movement will be a south to north flow, especially on those days that have meteorological conditions like those shown in FIGURE Nº 7. The most dangerous zone will be the Gibraltar Strait.

- During July, August, September and October the migratory movement will be with a north to south flow especially on those days thet have meteorological conditions like those shown in FIGURE Nº 8. The most dangerous zone will be the Gibraltar Strait.

- March, whose weather conditions are shown in FIGURE Nº 7 and 10, is the most dangerous month of the year. The second most dangerous time is the second half of October, on those days that have weather conditions like those shown in FIGURE Nº 8 and 9.

- After Gibraltar Strait and Pyrenees, the most dangerous zones are those marked with a circle - for examples passing zones - in FIGURES Nº3 and Nº4.

- All National and Natural Parks are considered dangerous due to the presence of birds (see Visual Navigation Chart 1/1.000.000 published by the Centro Cartográfico y Fotográfico del Ejercito del Aire.)

- The maneuver to avoid a bird strike will almost always be a resolute "pull up" but always while maintaining aircraft control.

- When flying in a low level formation, the leader must take into account the danger zones, and advise his wingman(men) to fly in a "deffensive" formation. If the overflight is performed in an "offensive" formation, then birds may be frightened by leader and may then strike the wingman(men). See FIGURE Nº 14.

- Every pilot who has a bird strike, should complete the OACI (ICAO) bird strike form that exists in all Spanish Air Force Squadrons. See FIGURE Nº 12.

- Any observation or dangerous situation related to birds must be relayed to the nearest Control Agency or to other aircraft in flight, and to the Squadron Flight Safety Officer.

6.- PROPOSALS

- To obtain and maintain good bird movement information, it is necessary to periodically (each 2 or 3 years) perform a bird census. A census is expensive, but it is possible to cooperate with the Sociedad Española de Ornitologia (SEO) whose aim is to sponsor census studies of new migratory routes. This society (SEO) consist of technicians and ornithologists who aid in developing new regilations to prevent birds strikes near aerodrome and airport zones.

- It would be possible to publish the most important bird map and graphs in order to show pilots the zones and the seasons that could be most dangerous. Those publications could be added to the low and high level Flight Manuals.

- It would be possible to make a complete study of the BIRDTAM System - used in the NATO countries - which is a National Radar-Visual Surveillance Net, that provides the most important bird movements each hour of the day and night. This net is paired with the meteorological net and transmits BIRDTAM notices by way of the same communication System.

- It would be interesting to ask the Instituto Nacional de Meteorologia (INM) for its cooperation in printing new phenologic maps and graphs of the most important bird species.

- It would be possible to ask the Instituto Nacional para la Conservacion de la Naturaleza (ICONA), for its cooperation in locating and moving if necessary those vulture feeding areas that are established near air-to-ground bombing ranges especially Las Bardenas Reales, which has a large population of vultures and similar birds.

- Ask the cooperation of the Guardia Civil in locating the illegal vulture feeding zones near the areas of heavy air traffic.

- Entrust the Meteorologic Services at each base, airport and air-to-ground range with the daily task of filling out the "Daily Bird Survey" form shown in FIGURE Nº13. By analyzing the data provided through these surveys, it would be possible to determine the need to apply special methods for the zones that require them. From statistical analysis of this data it would be possible to obtain valuable operational conclusions.

After a long and laborous study of the facts we feel that with a small economic investment it would be possible to save on costly repairs, aircraft lost, and possibly human lifes. ■

FIGURE Nº2

GROUPS OF SPANISH VULTURE ZONES.

1) Pirenaico Group: Pyrenees of Navarra and Huesca. Average altitude of the vulture sites is about 2900 ft. MSL. About 700 couples.

2) Cantabrico Group: North of Burgos and near Santander, Asturias and País Vasco. Average altitude of the vulture sites is about 2.500 ft. MSL. About 120 couples.

3) Norteiberico Group: Rioja, south of Zaragoza and some sites in Soria. Average altitude of the vulture sites is about 3.200 ft. MSL. About 300 couples.

4) Subiberico Group: Teruel and near Castellón and Tarragona. Average altitude of the vulture sites, about 2.900 ft. MSL. About 250 copuples.

5) Castellano Group: South of Burgos, Soria, Segovia on one side and Guadalajara, Cuenca, and Madrid on the other side; high lands of the Duero and Tajo rivers. Average altitude of the vulture sites 3.100 ft. MSL. About 400 couples.

6) Salmantino-Zamorano Group: Duero river and its tributaries near the Portuguese border. Average altitude of the vulture sites 1.800 ft. MSL. About 180 couples

7) Extremeño Group: Caceres and Badajoz. Most of the vultures live near the Tajo River. Average altitude of the vulture sites 1.600 ft. MSL. About 400 couples.

8) Marianico Group: Sierra Morena in Ciudal Real, Jaen, Cordoba, and Sevilla. Average altitude of the vulture sites 750 ft. MSL. About 70 couples.

9) Betico Group: Sierras Beticas, such as Sierra Cazorla which extends from Murcia to the south of Cordoba. Average altitude of the vulture sites 4.500 ft. MSL. About 60 couples.

10) Gaditano Group Sierra Betica, from Ronda to the Giblatar Strait. Average altitude of the vulture sites 1.400 ft. MSL. About 650 couples.

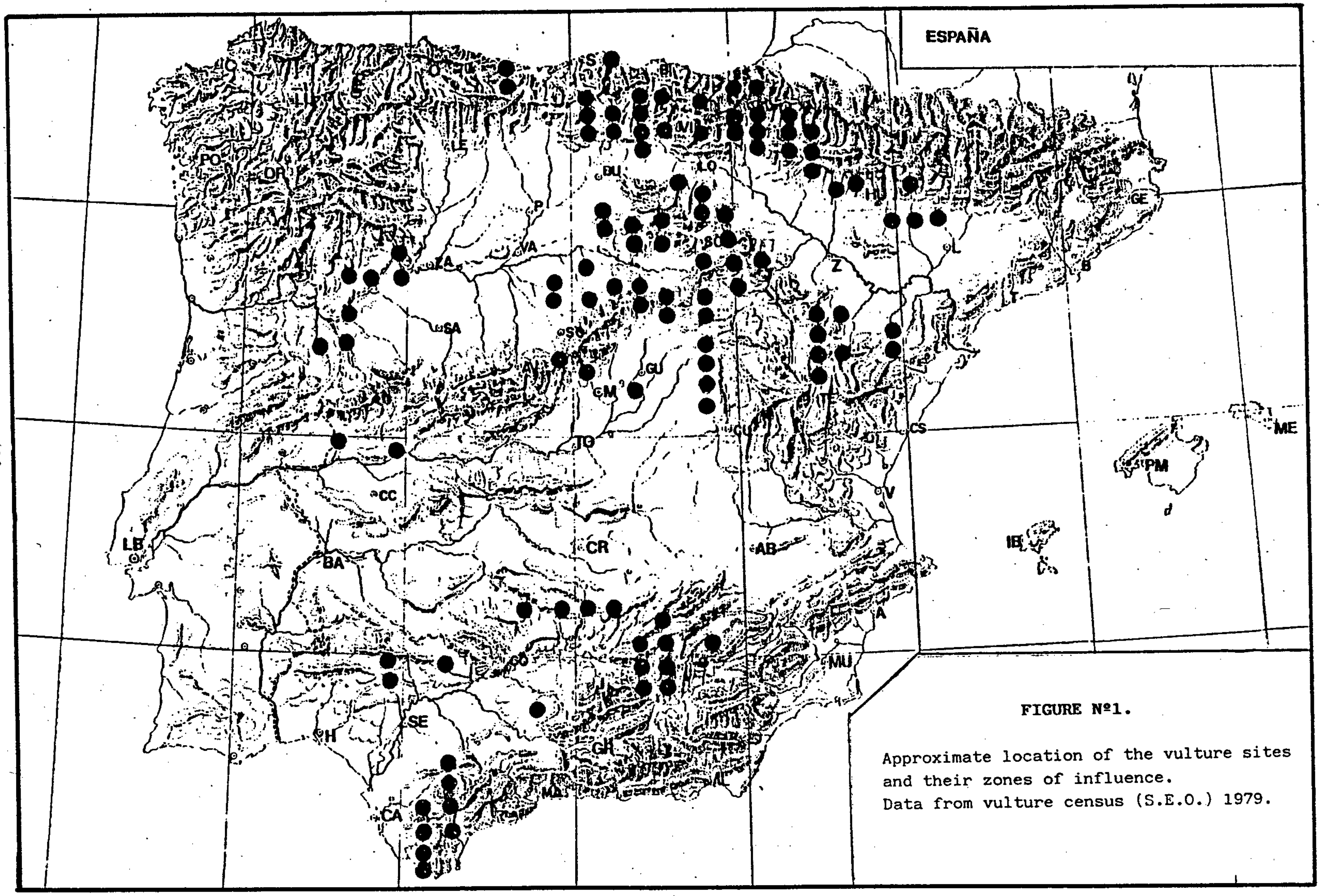


FIGURE Nº1.

Approximate location of the vulture sites and their zones of influence.
Data from vulture census (S.E.O.) 1979.

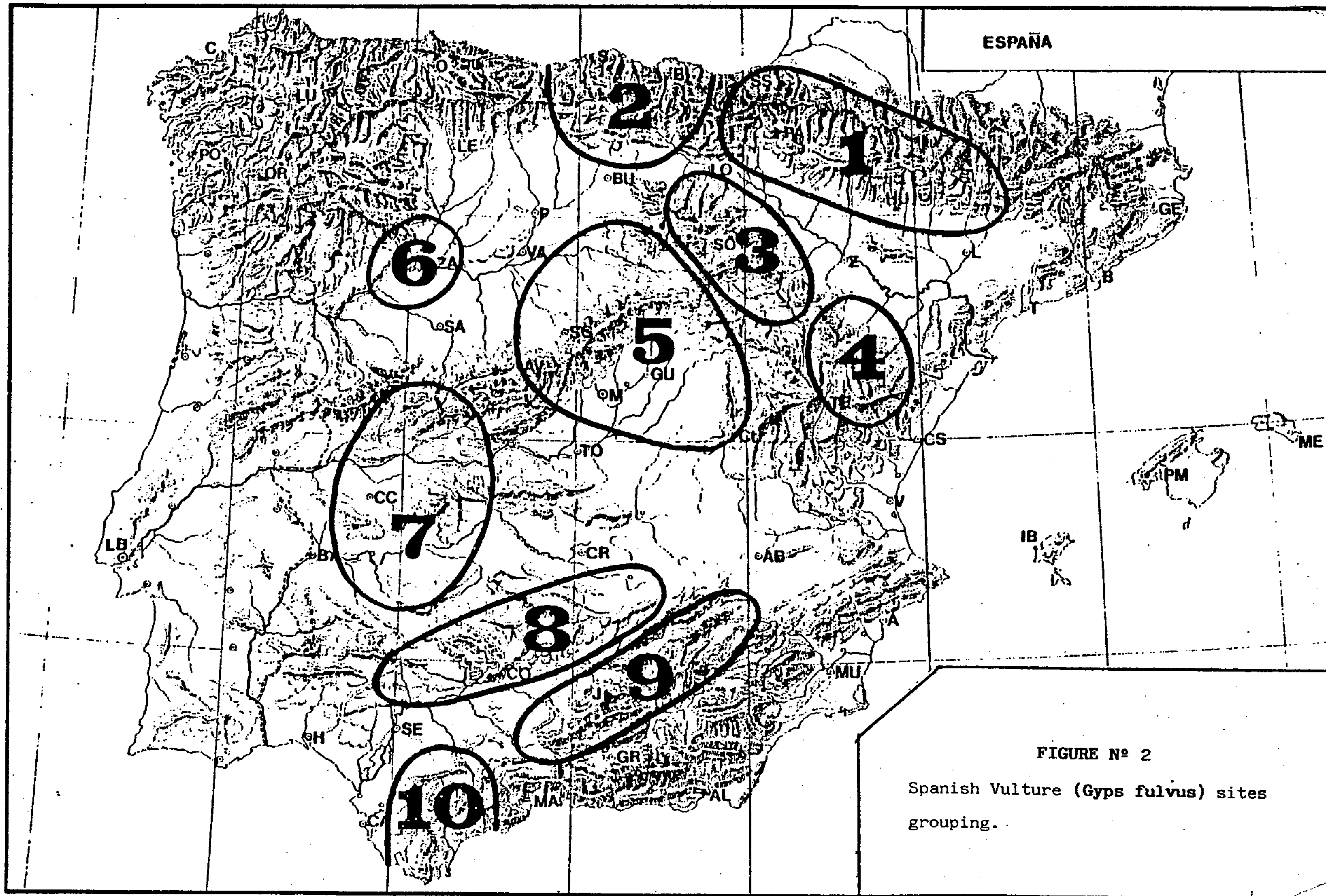


FIGURE Nº 2

Spanish Vulture (Gyps fulvus) sites grouping.

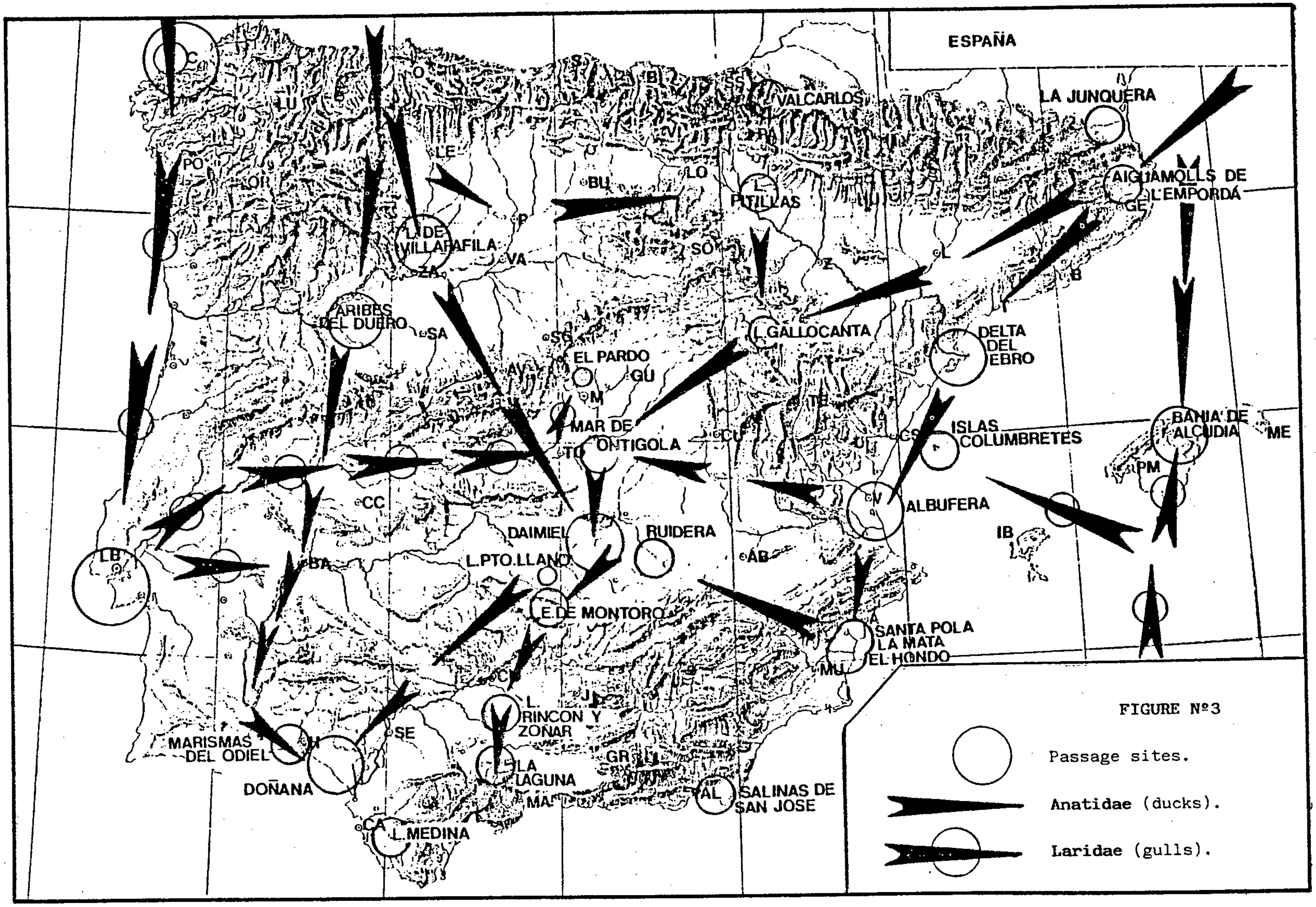


FIGURE Nº3

Passage sites.

Anatidae (ducks).

Laridae (gulls).

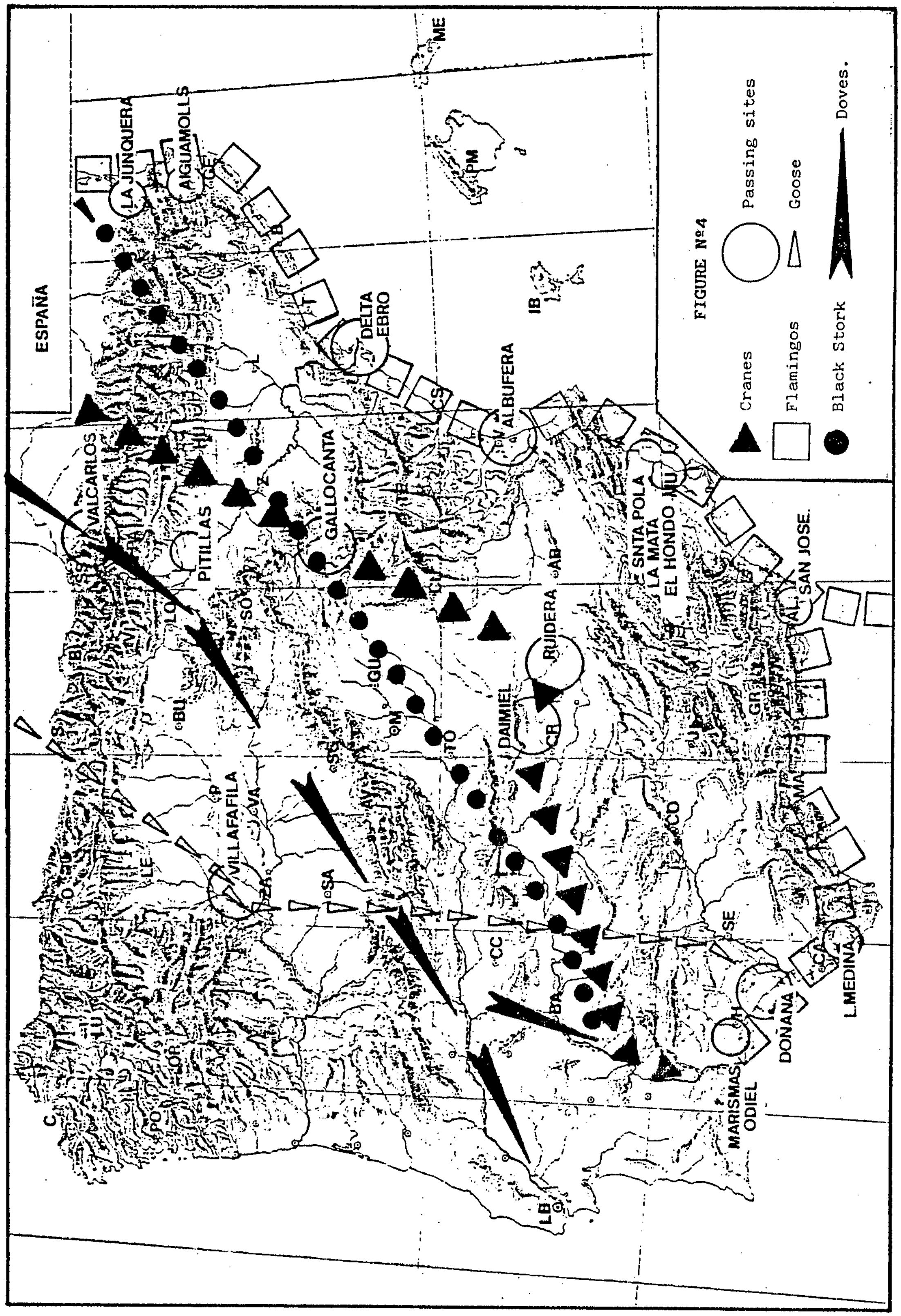

ESPAÑA
LA JUNQUERA
AIGUAMOLLS
DELTA EBRO
ALBUFERA
VALCARLOS
PITILLAS
GALLOCANTA
RUIDERA
DAIMIEL
VILLAFAFILA
SNTA POLA
LA MATA
EL HONDO
SAN JOSE
DOÑANA
L.MEDINA
MARISMAS ODIEL
FIGURE Nº4
Cranes
Flamingos
Black Stork
Passing sites
Goose
Doves.

FIGURE Nº3 and Nº4

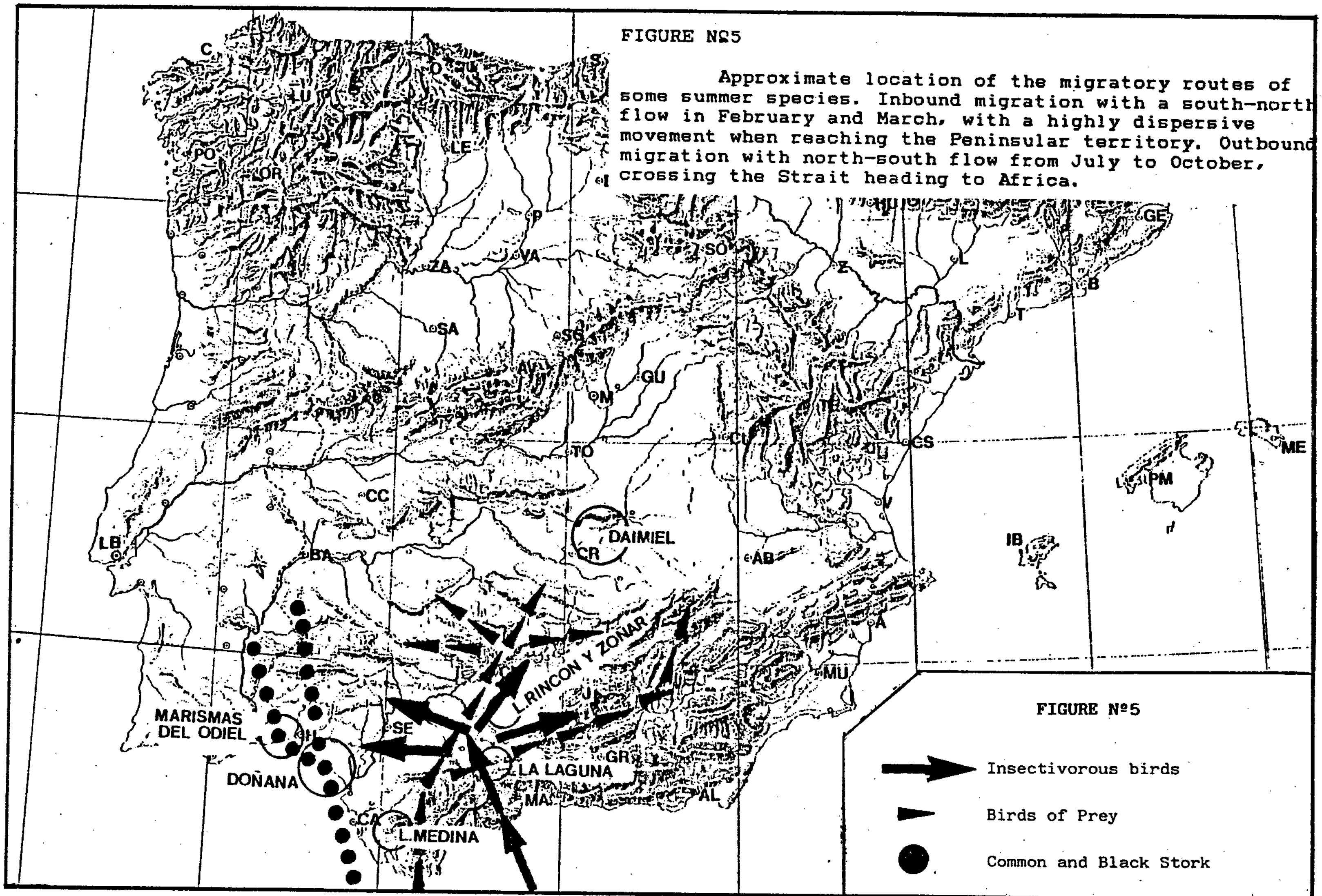
Approximate location of the migratory routes of each species shown. Inbound migration with north-south flow from the first half of October until the end of November. Outbound migration with south-north flow from March to April.

Flying altitudes vary from 1.000 to 1,500 ft. MSL. for flamingos (Phoenicopterus ruber) and some geese (Ansarinae), upto 11.000 fts. MSL. for some ducks (Anatidae). Flamingos usually fly in a corridor about 50 Kms. wide on eitherside of the coastline.

DIFFICULT PASSAGES: These pasages are said to be difficult primarily because of the mountainous terrain found in the Pyrennee System, especially la Junquera (Gerona) and Valcarlos (Navarra), and the Sistema Central (Molina de Aragon, Ayllon and Sierra of Guadarrama and Gredos). The Gibraltar Strait zone is classified as a difficilt passage zone due to the high density of birds, primarily found in Doñana Natioal Park. The number of winter birds here may reach one million.

FIGURE Nº5

Approximate location of the migratory routes of some summer species. Inbound migration with a south-north flow in February and March, with a highly dispersive movement when reaching the Peninsular territory. Outbound migration with north-south flow from July to October, crossing the Strait heading to Africa.



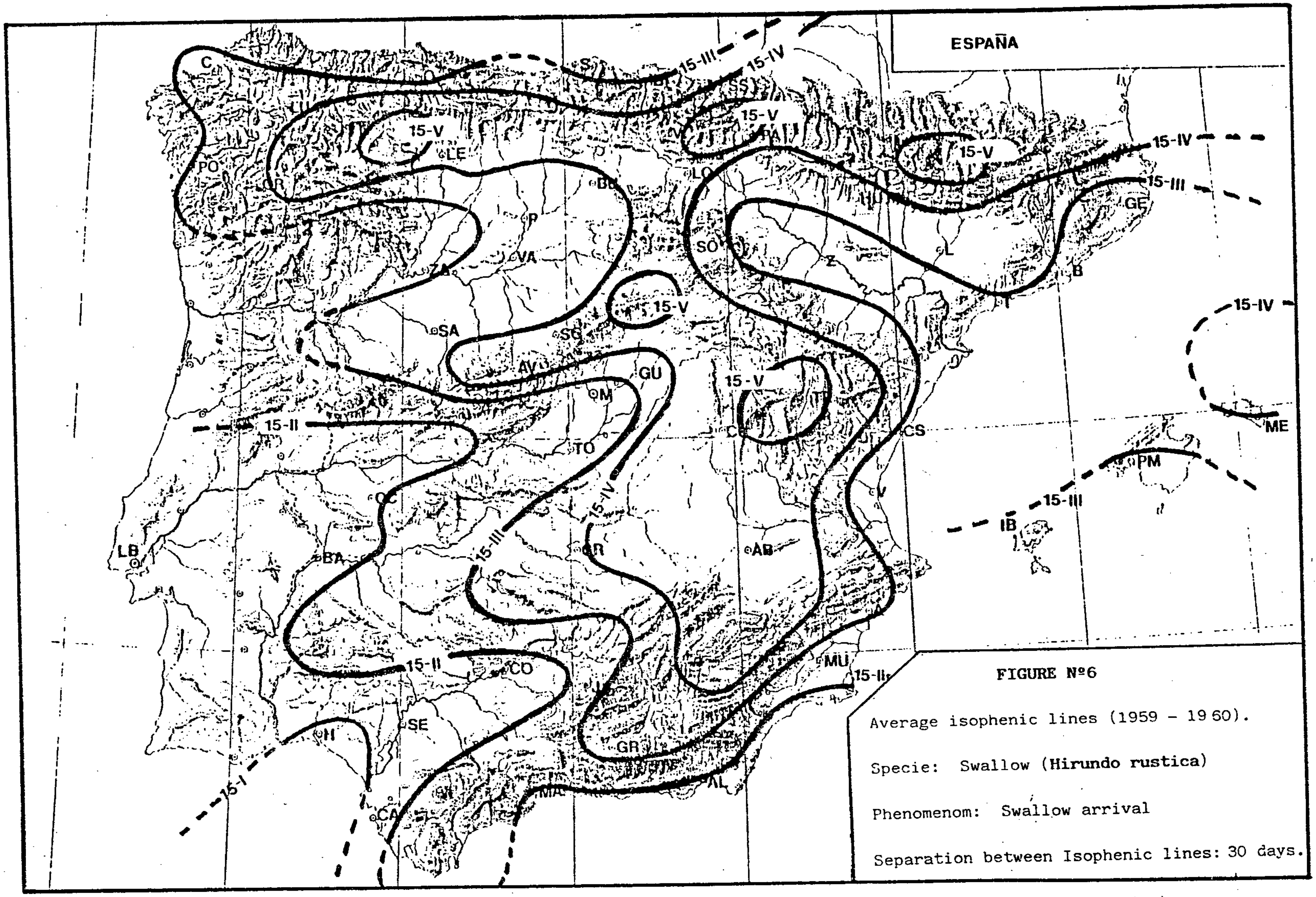


FIGURE Nº6

Average isophenic lines (1959 - 1960).

Specie: Swallow (**Hirundo rustica**)

Phenomenom: Swallow arrival

Separation between Isophenic lines: 30 days.

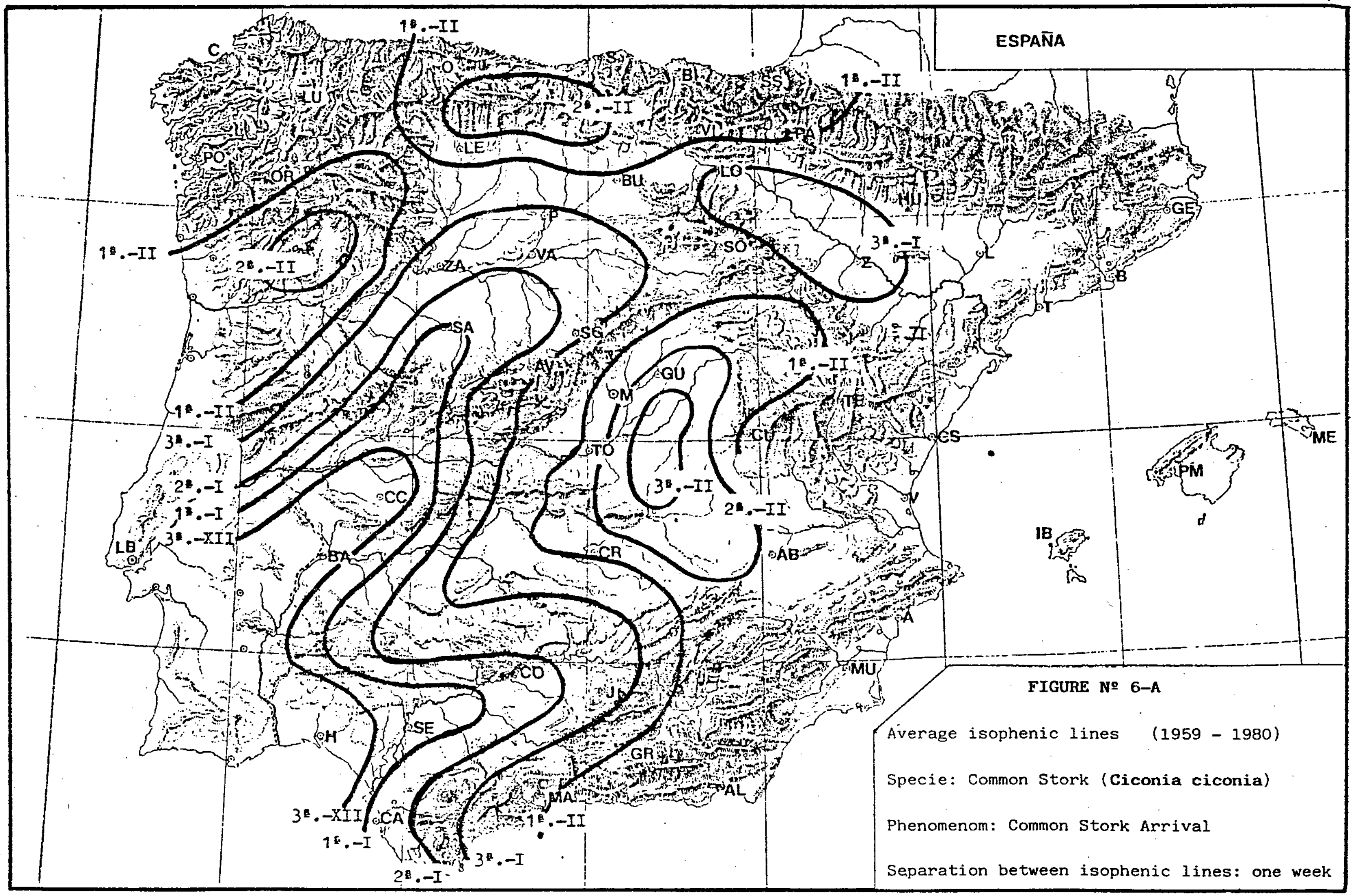


FIGURE Nº 6-A

Average isophenic lines (1959 - 1980)

Specie: Common Stork (**Ciconia ciconia**)

Phenomenom: Common Stork Arrival

Separation between isophenic lines: one week

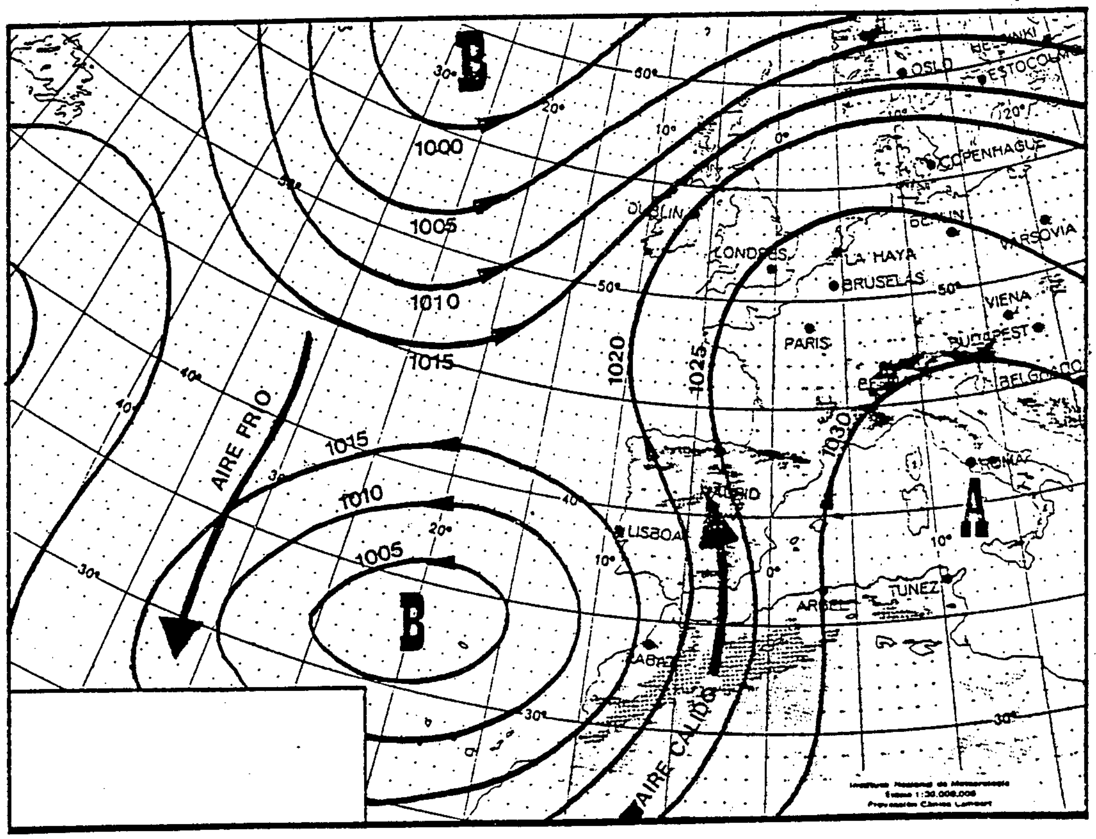


FIGURE Nº7

Meteorologic conditions which help the Spanish inbound migratory movement of Summer birds proceeding from Africa, during February and March.

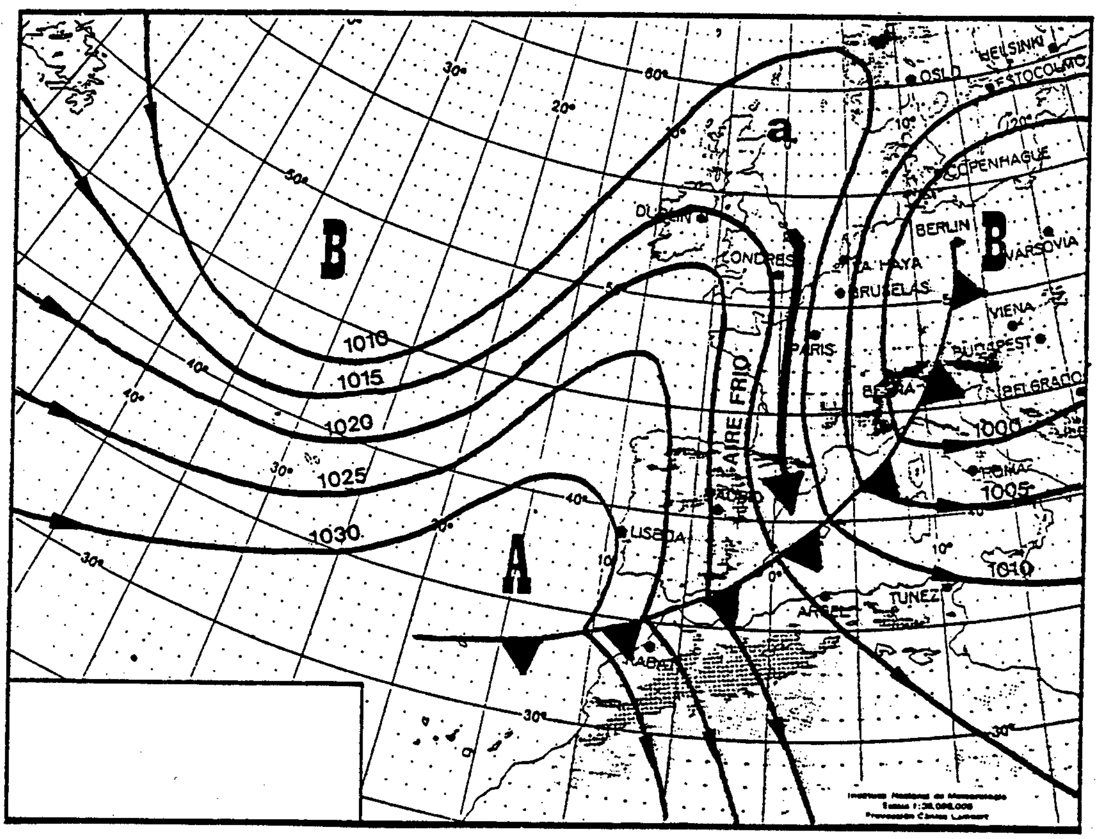


FIGURE Nº8

Meteorologic conditions which help the Spanish outbound migratory movement of Summer birds heading to Africa, during July, August, September and October.

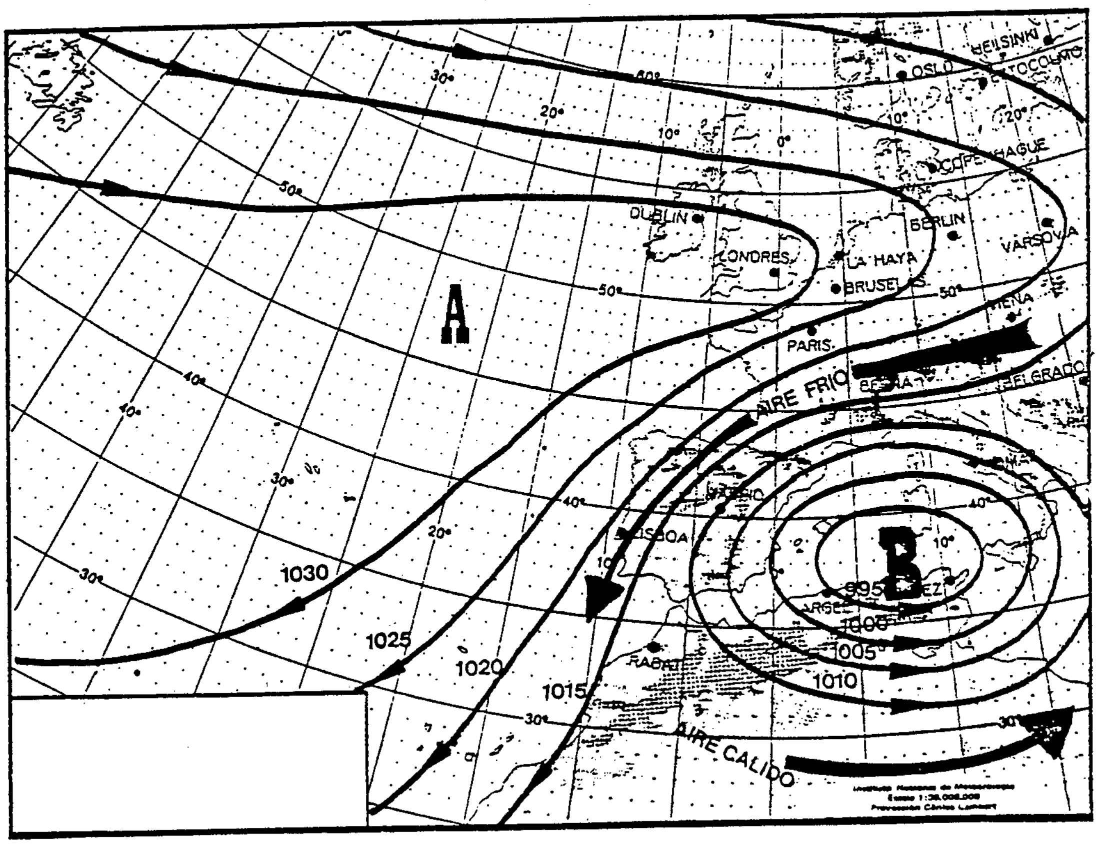


FIGURE Nº9

Meteorologic conditions which help the Spanish inbound migratory movement of winter birds proceeding from Central Europe and the Scandinavian countries, during the second half of October and the entire month of November.

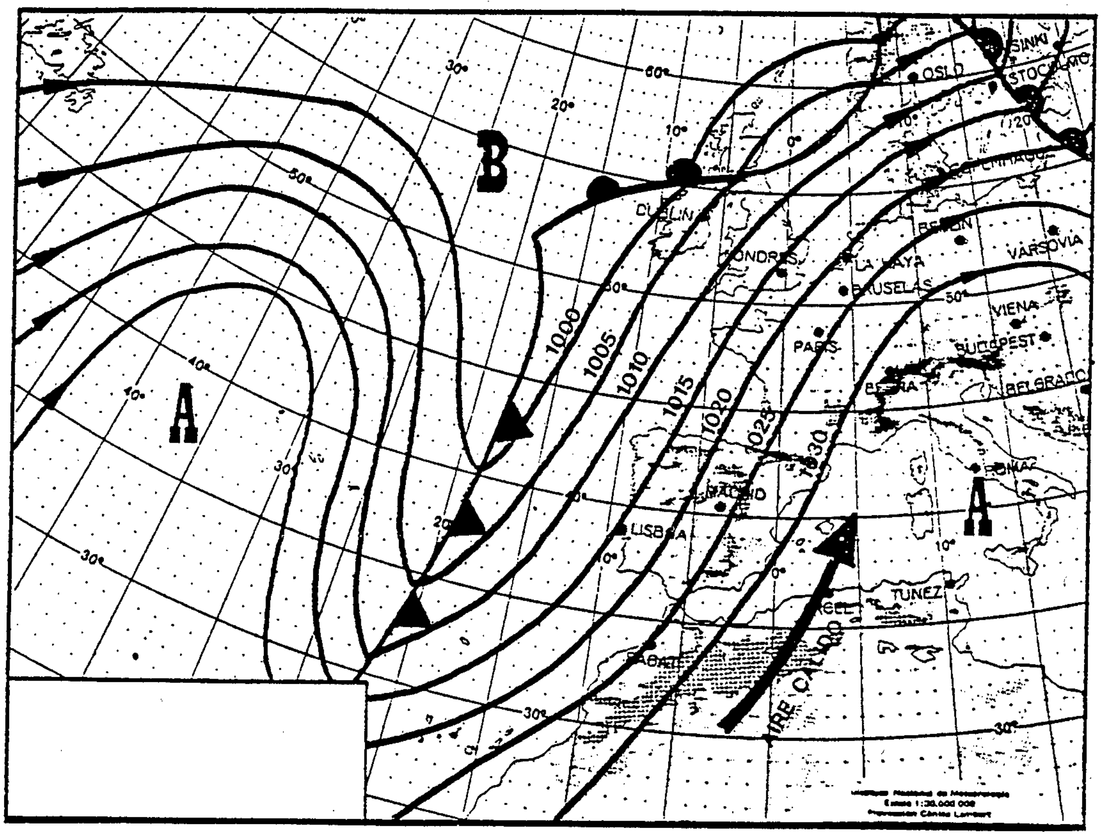


FIGURE Nº10

Meteorologic conditions which help, the Spanish outbound migratory movement of winter birds proceeding from Africa and heading to Central Europe and the Scandinavian countries, during March and April.

FIGURE Nº 11

KIND OF BIRD	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
SUMMER			outbound							inbound		
WINTRY		inbound					outbound					
OVERLAP												

Periods of the greatest migratory activity of Wintry and Summer birds inbound and outbound from Spain.

Note the overlap periods which are the most dangerous.

FIGURE Nº12

ICAO Bird Strike reporting form.

FORMULARIO DE NOTIFICACIÓN DE CHOQUES CON AVES

Envíese a:

Explotador 01/02

Marca/modelo de aeronave.................. 03/04

Marca/modelo de motor 05/06

Matrícula de la aeronave 07

Fecha *día....... mes...... año..........* 08

Hora local.................................. 09

alba ☐A *día* ☐B *crepúsculo* ☐C *noche* ☐D 10

Nombre del aeródromo 11/12

Pista utilizada.............................. 13

Situación, si fue en ruta..................... 14

Altura......................... *pies* 15

Velocidad indicada........... *nudos* 16

Fase del vuelo 17

estacionamiento ☐A *en ruta* ☐E
rodaje ☐B *descenso* ☐F
recorrido de despegue ☐C *aproximación* ☐G
ascenso ☐D *recorrido de aterrizaje* ☐H

Partes de la aeronave

	Golpeadas		Dañadas
radomo	☐	18	☐
parabrisas	☐	19	☐
proa (con exclusión de 18 y 19)	☐	20	☐
motor Núm. 1	☐	21	☐
2	☐	22	☐
3	☐	23	☐
4	☐	24	☐
hélice	☐	25	☐
ala/motor	☐	26	☐
fuselaje	☐	27	☐
tren de aterrizaje	☐	28	☐
cola	☐	29	☐
luces	☐	30	☐
otras partes (especifíquense)	☐	31	☐

Consecuencias para el vuelo

ninguna ☐32
despegue interrumpido ☐33
aterrizaje por precaución ☐34
se apagaron los motores ☐35
otras (especifíquense) ☐36

Condiciones del cielo

cielo despejado ☐A
algunas nubes ☐B
cielo cubierto ☐C

Precipitación

niebla ☐38
lluvia ☐39
nieve ☐40

Especie de ave*............................. 41

Número de aves

	Observadas 42	Golpeadas 43
1	☐A	☐A
2-10	☐B	☐B
11-100	☐C	☐C
más	☐D	☐D

Tamaño de las aves 44

pequeñas ☐S
medianas ☐M
grandes ☐L

¿ Se advirtió al piloto del peligro? 45

sí ☐Y *no* ☐X

Observaciones *(descríbanse los daños y las lesiones y consígnense otros datos pertinentes)* 46/47

....
....
....
....
....

Notificado por ....
(Facultativo)

**Envíense los restos de las aves a*

ESTA INFORMACIÓN SE NECESITA PARA FINES DE LA SEGURIDAD DE LA AVIACIÓN

Formulario de la OACI de notificación de choques con aves

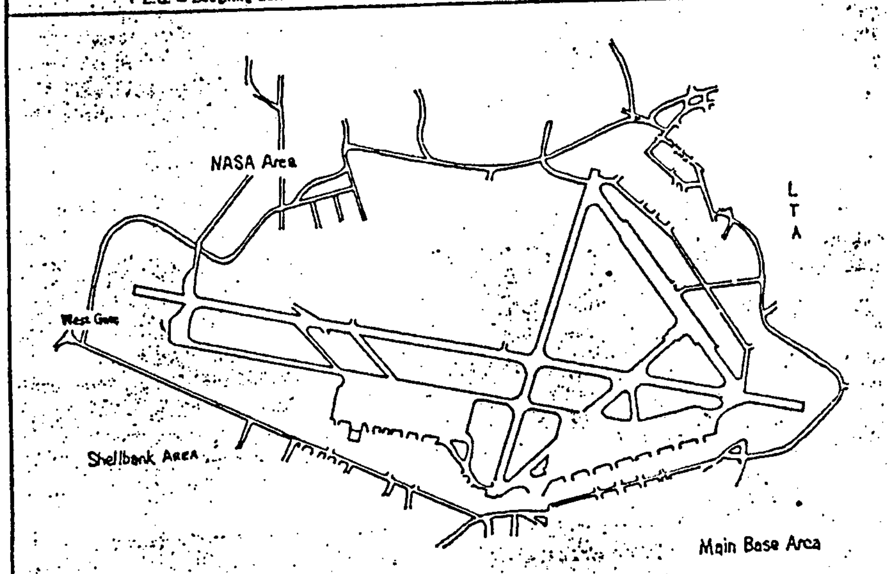
DAILY BIRD SURVEY

DATE:	TEMPERATURE:	WIND:	CLOUDS:

TIME:	RAINING, SNOWING:	GROUND CONDITIONS:

INITIALS:	BIRD WATCH CONDITIONS:

BIRD CODES: H.G. – Herring Gull; L.G. – Laughing Gull; B. – Blackbirds (Starlings, Grackles, etc.); R. – Raptors (Hawks, Owls, etc.); P. – Passerines (Sparrows, Robins, etc.); O. – Other



NO.	CONDITIONS	ACTION TAKEN	RESULTS
1.			
2.			
3.			
4.			

LAFB FORM JUN 78 0-2

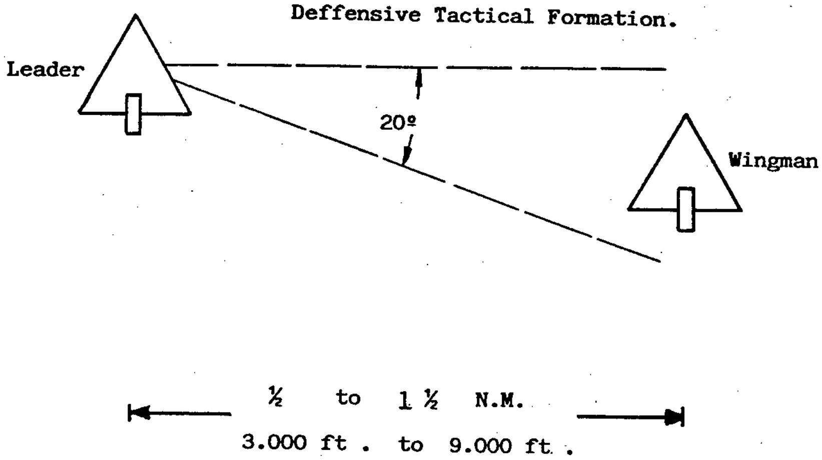
Langley AFB Daily Bird Survey

FIGURE Nº13

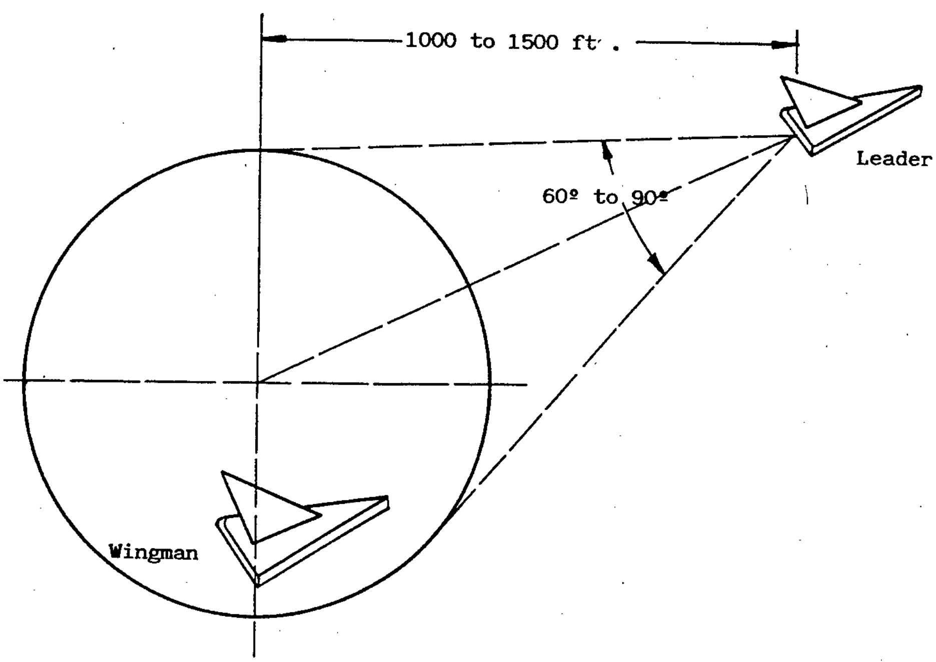
Daily Bird Survey for an airport zone.

FIGURE Nº 14

Deffensive Tactical Formation.



Offensive Tactical Formation.



ADF616005

Improving birdstrik resistance of aircraft windshields

(R. J. Speelman and R.C. McCarty, USA)

BSCE 19 / WP 8

Madrid, 23-28 May 1988

IMPROVING BIRDSTRIKE RESISTANCE OF AIRCRAFT WINDSHIELDS

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ABSTRACT

USAF aircraft repeatedly prove that birds and aircraft cannot occupy the same airspace at the same time; over 3000 birdstrikes per year cause millions of dollars in damage to USAF aircraft. During the past 18 years 13 aircrew members have been killed and 21 aircraft have been destroyed due to bird impact. More of these losses are due to birdstrikes on the windshield subsystem than to any other subsystem. Windshield systems on several different aircraft are being redesigned to provide improved tolerance of the birdstrike event. These efforts to improve windshield system birdstrike resistance will be discussed in general terms as will the rationale behind these efforts. Some technical voids in designing for, and integration of, birdstrike resistance will be discussed.

Status report/working paper to be presented in fulfillment of responsibilities as member of Structural Testing Working Group at the Birdstrike Committee Europe Meeting, 23-27 May 1988, in Madrid, Spain

ADF 616006

The development of an effective bird detection and dispersal programme

Callum Thomas, England

BSCE 19/ WP 9

Madrid, 23-28 May 1988

THE DEVELOPMENT OF AN EFFECTIVE BIRD DETECTION AND DISPERSAL PROGRAMME

Dr. Callum Thomas, Bird Control Officer, Manchester Airport, England.

Summary

Bird detection and dispersal operations require a detailed knowledge of the habits of the bird population at each airport. Bird dispersal can take hours or even days to become effective and requires persistence and dedication on the part of those staff involved in the task and also the trust and understanding of air traffic controllers. For these reasons, there is a need for bird detection and dispersal operations to be concentrated amongst a small group of individuals who work to the demands of the birds. Effective bird detection and dispersal operations can lead to a reduction in bird strikes, a reduction in the number of birds which regularly come to the airfield and a reduction in the time required to disperse those birds. The result of this can be a dramatic reduction in operating costs.

1. INTRODUCTION

Habitat modification, designed to make an airfield less attractive to birds is an essential component of any bird hazard management programme. However, since this method is never totally effective, the cornerstone of any bird control programme remains an effective bird detection and dispersal operation.

Methods of bird dispersal have changed very little over the years, however, developments in our knowledge of bird behaviour and ecology, and in particular, a better awareness of the individual nature of the bird hazard at each airport means that more effective use can be made of these standard techniques.

This paper aims to describe the way in which the principles of bird detection and dispersal should be tailored to the demands of the bird hazard at a particular airport. In so doing it attempts to clarify the essential difference which exists between bird scaring and bird management.

Data presented below relate to the bird hazard management programme at Manchester Airport which was designed to deal primarily with the hazard posed by lapwings and gulls.

2. THE PRINCIPLES OF BIRD DETECTION

Although an airport is intrinsically attractive to some species of birds, others visit it whilst en route to another site and may only use it at certain times of the day. Even those airports on which the number of "resident" birds is comparatively small can face a serious bird hazard where the environment surrounding the airport is diverse and rich and, therefore, full of birds. Since some species of bird fly long distances each day between their roost or nest and their feeding areas (for example, gulls will fly upto 50 miles per day in search of food) a very large area of countryside surrounding an airport can provide the source of a bird hazard.

Although there are some predictable patterns to the behaviour of birds in a particular locality, these change seasonally, and even on a day to day basis. The result is that in theory, flocks of birds may appear over the perimeter fence at any time and from any direction and land on the runway. Despite the flat nature of an airport, its large size makes it impossible to carry out effective detection of birds from a single fixed point, even a well positioned control tower.

3. THE DEVELOPMENT OF A BIRD DETECTION PROGRAMME

The level of bird control cover provided at a particular locality will be dependent upon the extent of the bird hazard and also the economics of the airport. At some airports, bird detection involves little more than an occasional inspection of the runway before aircraft movements, or even a visual inspection from the control tower. Where regular (for example two hourly) bird patrols are carried out, they are often provided by staff (such as the Airport Fire Service) whose primary responsibility lies elsewhere and often, the frequency of patrols is dictated by the other duties of those staff rather than the demands of the birds. The only truely effective method involves the provision of dedicated staff who can spend their entire working day patrolling the airfield, if the extent of the bird hazard demands it.

4. THE PRINCIPLE OF EFFECTIVE BIRD DISPERSAL

Those birds which use the airport en route to other sites can often be dispersed with comparative ease using standard techniques, however, those species which are attracted to the airport itself will tend to be more persistent.

There is a tendency for flocks of birds which are loafing in remote corners of an airfield (and even, sometimes, at sites quite close to the runway) to be allowed to remain if they show the least sign of persistence. This practice, which is at best short sighted and at worst dangerous, arises both because of limitations in the amount of time which can be allocated to bird control by staff whose prime responsibilities lie elsewhere and also because bird dispersal carried with it a degree of hazard to aircraft and Air Traffic Controllers are often unwilling to allow dispersal to take place when aircraft are taking off and landing.

There are a number of reasons why all flocks of birds should be dispersed at the earliest reasonable opportunity:

1. A flock of birds on the ground can act as attractant to others overflying the airport. These come down and join the existing flock thereby increasing the numbers on the airfield.

2. Small flocks of birds are comparatively easy to disperse in a controlled manner, however large flocks can be dangerous since they may split up

into a number of small flocks which fly in several directions.

3. While a flock remains on the ground, it offers no immediate threat to an aircraft (unless, of course, it is on the runway). However, it may be disturbed at any time and fly up in a dangerous and uncontrolled manner. The bird officer can, however, select when and in what way to disperse the flock.

4. The ease with which a flock of birds can be dispersed from an airfield varies between species (lapwings are particularly persistent). If a flock is allowed to remain on an airfield for any length of time, the birds become more resistant to dispersal action. In the short term they learn that with a little persistence they will be allowed to settle again. In the longer terms, if the birds are allowed to return day after day, they start to include the airport as part of their daily routine. Birds are most easily dispersed if attacked while they are still in the air before they have settled on the airfield.

Lapwings are responsible for a high proportion of bird strikes reported in western Europe. The lapwing problem is, in the main associated with the autumn and winter months when the birds revert to their flocking habit which persists until the following spring. When flocks arrive back in late summer the numbers are small, however, at this time of year, at most civil airports, air traffic is at its maximum. Due to the disruptive effects of bird dispersal operations, there is a temptation to allow these small flocks to remain undisturbed. By late autumn, when air traffic numbers have declined, the resident bird flock has increased to a hazardous level. However, since a significant proportion of these individuals have used the airfield as part of their daily routine for weeks or even months, they are almost impossible to disperse. Bird dispersal can only be successful if it is started as soon as the birds move into the area and maintained throughout the period that they are there.

The effectiveness of this theory may be assessed from bird dispersal operations mounted against lapwings at Manchester Airport over the past three years. The numbers which attempt to use the airfield on a regular basis have been dramatically reduced (Fig. 1) and those which do return can be easily driven off. The result has been a marked decline

in the number of strikes involving lapwings from approximately 12 per year to only 2 in 1986 and 0 in 1987.

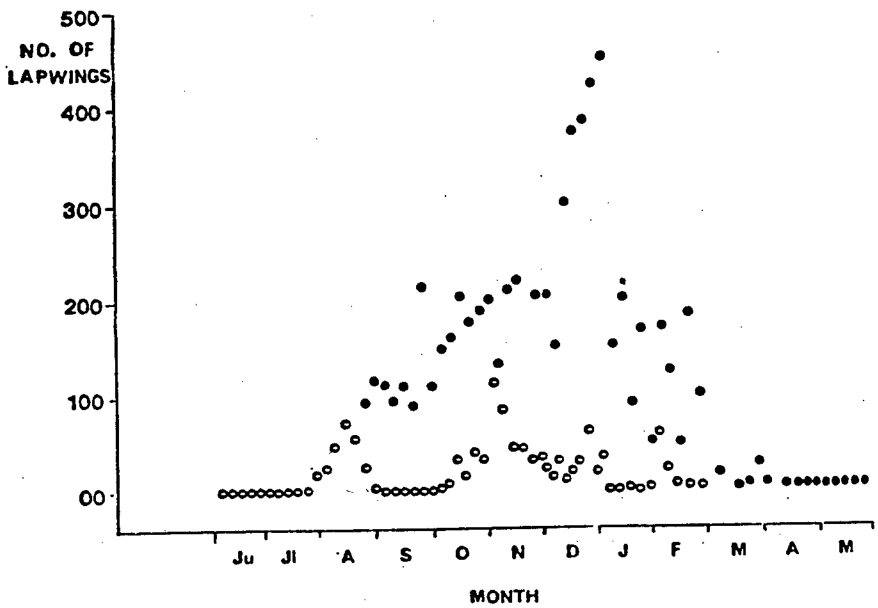


Fig. 1: The number of lapwings which regularly use Manchester Airport as a loafing site before (o) and after (o) the introduction of comprehensive detection and dispersal operations.

Bird dispersal operations may take only a matter of minutes, however, frequently they can require an hour to be effective. A persistent flock may require continuous dawn to dusk scaring for a number of days in order to break its allegiance to the airport, however this can be avoided if dispersal is started as soon as the birds arrive in the area.

Observations on the movements of different types of birds will indicate the direction in which they will most easily be driven off. This requires the maintenance of detailed records and also an intimate knowledge of the local bird populations.

5. ALLOCATION OF RESOURCES

Theoretically, birds may arrive and settle on an airfield at any time through the day or night, however, in practice there are general patterns in the behaviour of birds which, if identified, can be used to predict the times of day, or of year when the hazard is greatest. The way in which these patterns manifest themselves is dependent upon the reasons why the birds come into the vicinity of the airport and also the opportunities for feeding, loafing, breeding or roosting at other sites in the surrounding countryside. For example, the extent of the hazard at a coastal airport is likely to be determined to a large extent by the state of the tide.

An analysis of bird strike statistics can give an indication of the times of day and times of year when the hazard is greatest, however these data should be viewed in conjunction with field observations in order to develop a complete picture.

Gulls pose the single most serious avian threat to aircraft safety at Manchester Airport and account for 40% of all bird-strikes. An analysis of gull related strikes revealed that:

1. Three quarters occurred on the runway itself, 80% below 50' and 90% below 100'.

2. Strikes occurred from late summer until spring and reached a peak in November when 1 could be expected every ten days.

3. Over 70% of strikes were reported within 2 hours of sunrise.

4. Strikes occurred more frequently on days when it was raining.

5. All gull strikes reported during the approach or climb phase occurred in the same airspace (over the western perimeter of the airport).

6. A half of all gull related strikes occurred less than six minutes after the previous aircraft had used the runway.

Field observations revealed that the gull hazard is associated with a large winter night roost on an area of open water 4 miles away from the airport. The birds leave the roost at dawn and fly out into the surrounding countryside in search of food. A marked gull flightline crosses the western approach to the airfield, normally at 200-300'. The gull movement is generally from north west to south east at dawn and is reversed at dusk. The seasonal change in the size of the roost corresponds to the change in the number of strikes recorded each month. The diurnal variation in strikes corresponds to the numbers crossing the airfield at different times of the day. An analysis of weather records showed that more gulls crossed the airfield on days when conditions were wet (when it was raining or had recently rained). However, despite these apparent trends in the data, there was remarkable day to day variability in numbers with remains to be explained.

From these data, therefore, it is possible to detect a general pattern of times and conditions in which the strike hazard is greatest and during which bird detection and dispersal operations should be maximised. In addition, it has become apparent that dispersal operations in the morning should, in general, aim to drive birds towards the south east and in the afternoon towards the north west. A Bird Control Officer (whose sole responsibility is to detect and disperse birds) is present at the airport from dawn to dusk throughout the year (very few strike occur at night) however plans have now been drawn up to double the cover during the period around dawn when the hazard posed by gulls is greatest.

Thus we have been able to make the more effective use of our resources with comparatively little detailed knowledge of the bird hazard. Data are still being collected and in the future it is hoped to develop a multivariate model of factors which influence numbers of birds crossing the airfield each day. This will permit more accurate predications both for reasons of manpower management and also for warning pilots.

The finding that gull strikes result from large numbers of birds crossing the airfield during a short period of time, that they occur in conditions of poor visibility, at a time when air traffic activity is high and also that strikes occur very shortly after the previous movement along the runway, suggests that bird detection and dispersal will not be the long term solution to this problem. Accordingly, efforts are being made to reduce the number of gulls in the vicinity of the airport either by dispersal of the night

roost or through changes to farming practice in the surrounding countryside.

6. THE RELATIONSHIP WITH ATC

The freedom of movement and action which is a necessary prerequisite to successful bird dispersal operations requires the understanding and trust of ATC staff. It is important therefore, that a dialogue be maintained between the two groups and also that an individual controller knows the ability of, and limitations of the person who is actually carrying out bird control on the manoeuvring area.

7. THE COST OF COMPREHENSIVE DETECTION AND DISPERSAL OPERATIONS

The employment of dedicated bird control staff is obviously an additional drain upon an airports' financial resources, although it can never be measured against the potential savings to the aviation industry generally. However, bird control staff can take on additional duties, providing they work primarily to the demands of the birds and particuarly if those duties involve them working out on the airfield itself. There is evidence from a number of airfields, however that improved bird detection and dispersal operations can lead to a dramatic reduction in the use of bird scaring cartridges since the birds become less persistent in their attempts to return to the airport. The financial savings in shell cracker use at Manchester Airport have been sufficient to pay the salary of one full time bird control officer (Table 1). (Intensive bird detection and dispersal operations started in the middle of 1985).

Table 1: The annual cost of bird scaring cartridges used at Manchester Airport.

Year	1982	1983	1984	1985	1986	1987
Cost	£13,108	£12,831	£ 9,193	£3,747	£2,670	£1,638

8. THE EFFECTIVENESS OF COMPREHENSIVE DETECTION AND DISPERSAL

Data are available from Manchester Airport for the period before and after the estabishment of a Bird Control Unit and the instigation of full time bird detection and dispersal operations. These indicate that improved bird control on the airfield has resulted in (see Table 2).

1. A decline in the bird strike rate.

2. A reduction in the proportion of strikes involving birds which are comparatively straight forward to control.

3. A reduction in the number of birds which regularly use the airfield. (Data from Fig. 1 for October - January).

4. A reduction in the effort required to disperse those birds which do come to the airfield (as measured by the number of bird scaring cartridges used).

Table 2: Measures of the effectiveness of part-time and full-time bird detection and dispersal operations.

	Part-time	Full-time
1. No. strikes per 1000 movements	4.1	2.5
2. % strikes involving easily controlled birds	76	28
3. Average number of resident lapwings	214	31
4. Bird scaring cartridges/ year	10921	2420

ADF616007

Terms of reference of the steering committee of BSCE

Steering Committee

BSCE 19 /WP 10

Madrid, 23-28 May 1988

TERMS OF REFERENCE OF THE STEERING COMMITTEE OF BSCE

Presented by the Steering Committee

The present composition of the Steering Committee is as follows:

(i) The BSCE Chairman and vice chairman
(ii) The previous BSCE Chairman, if possible
(iii) The chairman of each BSCE working group
(iv) The observer from ICAO
(v) A representative from the host state.

At a Steering Committee meeting on 10 September 1987, it was agreed to change the composition of the Steering Committee as follows:

(i) The BSCE Chairman and vice chairman
(ii) The previous BSCE Chairmen, if possible
(iii) The chairman of each BSCE working group
(iv) The observer from ICAO
(v) Such persons whom the Steering Committee may wish to include
(vi) A representative from the host state.

The meeting is asked to approve the suggestion of the Steering Committee regarding the change of the composition of the Steering Committee.

ADF 616008

Caracterization of the Birdstrike hazards to the space shuttle orbiter

Major Jeffrey J. Short, USA)

BSCE 19 / WP 11

Madrid, 23-28 May 1988

CHARACTERIZATION OF THE BIRDSTRIKE HAZARDS TO THE SPACE SHUTTLE ORBITER

Major Jeffrey J. Short, USAFR
AFWAL/FIER
Wright-Patterson AFB OH 45433

ABSTRACT

The National Aeronautics and Space Adminstration requested an evaluation of the Space Shuttle Orbiter windshield system with regards to the possibility of birdstrikes. To support their damage assessment analysis, the Air Force Wright Aeronautical Laboratories Aircraft Windshield System Programs Office directed a characterization of the bird populations at the three primary Shuttle landing sites: Kennedy Space Center, Florida; Edwards AFB and Vandenberg AFB, California. The objective of this effort was to determine the expected birdstrike risk of Shuttle approaches/landings.

The USAF Bird Avoidance Model (BAM), developed for the Bird-Aircraft Strike Hazard Team by the University of Dayton Research Institute, is used to examine bird hazards on high-speed, low-level flight routes in the continental United States. The BAM calculates the birdstrike risk on a route by estimating the number of birds occupying the route airspace at a particular time. The BAM was used to determine the relative birdstrike risk to the Shuttle by defining the segments of a typical approach at each of the landing sites.

The BAM estimates for Kennedy Space Center (KSC) were multiplied by the proportion of the local bird population segregated into discrete weight categories. This yielded the probability of a birdstrike involving a bird of a particular weight. The bird population data was collected from the Merritt Island National Wildlife Refuge which is located adjacent to KSC. This analysis indicated that the chance of the Shuttle hitting a 2-pound bird is close to 4 per 100 approaches during the fall each year. One out of every 100 landings would involve a 3-pound bird during the fall and early winter. The predominant risk comes from waterfowl at KSC with the chance of encountering larger (over 4-pound) raptors greater during the summer.

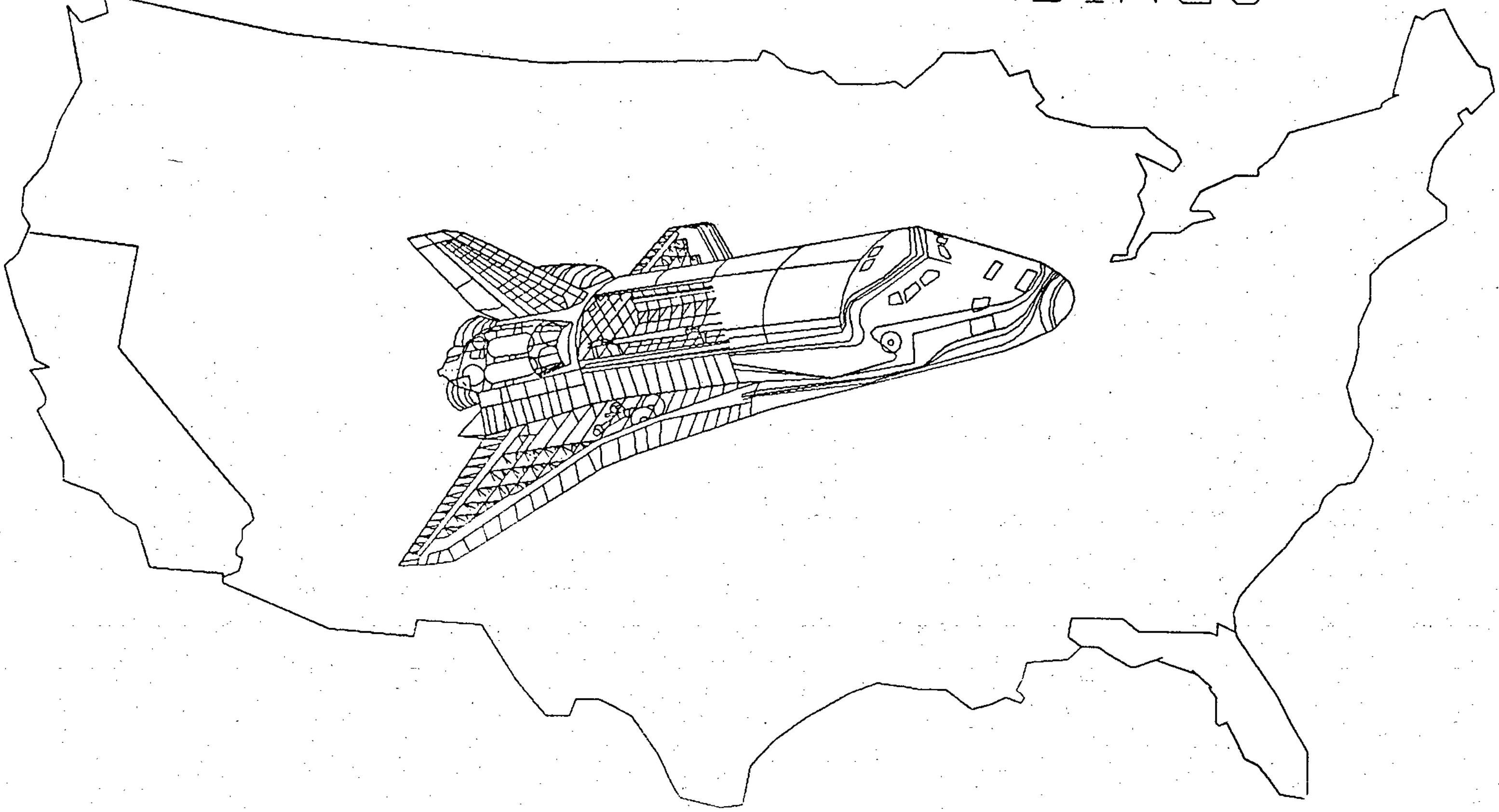
No discrete bird population data was available from the California sites so only the BAM estimates were used for comparison of birdstrike risk. The analysis showed that the birdstrike risk to the Shuttle is highest in the fall at all sites. Based on the BAM, the birdstrike risk ranges from 2 per 100 approaches at KSC and Edwards AFB to 2 per 1000 flights at Vandenberg AFB. Waterfowl create the majority of the birdstrike hazards during

from fall through early spring while raptors comprise the major hazard during the summer. Night landings would expose the Shuttle to the highest birdstrike risks, especially during the fall and spring migrations.

This was the first application of the BAM on other than military aircraft. Though the BAM is certainly an imperfect model, it provides a method of quickly estimating the relative birdstrike risk from waterfowl and raptor populations in the continental United States. More bird population data is needed for other bird species (gulls, blackbirds) known to present hazards to flight to improve the BAM's predictive ability.

Reliable bird population data from the region around the landing site, combined with the BAM estimates, can provide design engineers with a good idea of the bird hazards that the Shuttle will encounter during particular time periods. If some aspect of the design is inadequate to provide an acceptable level of birdstrike resistance, the flight hazards can be minimized by scheduling Shuttle landings at a particular site to a time when the birdstrike risk is lowest. If rescheduling is not feasible, then measures to reduce the birds along the Shuttle approach could be implemented.

BIRD STRIKE RISK FOR SPACE SHUTTLE LANDINGS



BIRDSTRIKE RISK FOR SPACE SHUTTLE LANDING SITES[1]

Jeffrey J. Short[2]
AFWAL/FIER
Wright-Patterson AFB OH 45433

INTRODUCTION

NASA has long been concerned with the possibility of birdstrike damage to the Shuttle. Beginning in 1974 (Reference 1), the Air Force's Bird-Aircraft Strike Hazard (BASH) Team has recommended measures to reduce the risk of birdstrikes at the Kennedy Space Center (KSC) Shuttle Landing Facility (SLF) and other operational landing sites. BASH Team assistance was provided to NASA several times in the last 7 years regarding the SLF. Over the past 10 years, the BASH Team has conducted surveys of the bird hazards at the other primary Shuttle landing sites, Edwards AFB and Vandenberg AFB, California. Once implemented, those recommendations made by the BASH Team effectively decreased the overall attractiveness of the airdrome to birds, considerably reducing bird hazards to both the Shuttle and other aircraft using the facilities.

The SLF is located next to the Merritt Island National Wildlife Refuge (MI NWR) which hosts hundreds of thousands of waterfowl and tens of thousands of waders, shorebirds, raptors and songbirds. The movement of these birds in and around the MI NWR constitute a significant hazard to the Shuttle (or other aircraft) landing at the SLF. One birdstrike is known to have occurred during a Shuttle landing at the SLF (Mission 1042A, 11 Feb 85 at 1215 hours GMT).

The objective of this study was to quantify the birdstrike hazard to the Shuttle at its three primary landing sites in the United States. One goal is to characterize the distribution of birds at the landing sites. Another goal is to determine the range of weights of those birds to model the expected amount of damage expected from a single birdstrike. Sufficient bird population data exist for the Florida site but the information needed for an in-depth study of the California sites is incomplete. Therefore, this report will concentrate on the bird hazards at the SLF.

1 Taken from AFWAL Technical Report 87-3083, A Characterization of the Birdstrike Risk to the Space Shuttle Orbiter at its Primary Landing Sites.

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DATA COLLECTION AND ANALYSIS

Bird Weight Distribution

Determining the weight distribution of birds requires knowledge about the predominant bird species of a population and their associated body weights. Bird weights vary with sex, age, subspecies and season. Combining this information with behavioral information on the chronology, geographic and vertical distribution of their movements provides the basic biological inputs into a hazard assessment model; i.e., how many birds of a known hazard potential might interfere with the Shuttle's approach.

Monthly waterfowl censuses (1978-84), performed by U.S. Fish and Wildlife Service (USFWS) and quarterly surveys of raptors, waders and shorebirds (Reference 2) were analyzed to characterize the bird population at MI NWR. Monthly waterfowl censuses were consolidated into quarters to be consistent with the survey data. Body weights were assigned to each species according to the highest mean weight published in "Body Weights of 686 Species of North American Birds" (Reference 3). No consideration was given to the sample size, whether the birds were male or female, their breeding condition, or the season they were collected. Where sample range (geographic distribution) was identified, the mean weights for the easterly occurring subspecies were used. All weights were converted to pounds.

Census data show that most waterfowl leave the MI NWR by May of each year and return in October. Large raptors are present year-round but comprise almost half of the bird population from April through September. Many raptors follow the Florida coastline during fall migration. The bird population data was separated into three groups to compare the weight distribution of the waterfowl, raptor and wader/shorebird populations (Table 1). Table 2 shows the consolidated distribution of weights for the three groups. The large numbers of waterfowl (311,900) eclipsed both raptor (3,387) and wader/shorebird (96,285) proportions of the total population at MI NWR.

The cumulative distribution frequency (CDF) of the weights of the bird populations at MI NWR were calculated from the annual proportion of each weight class for a bird group (see Table 1). Weights for the population samples involved in birdstrikes characteristically fit a Weibull curve (References 4 and 5). The CDF (Figure 1) for the MI NWR waterfowl population approximates a Weibull distribution but the raptor and wader/shorebird curves are flatter, indicating a higher percentage of heavy birds in the population; e.g., Black Vulture (4.7 pounds) and Wood Stork (6.0 pounds), respectively.

Figure 2 shows the CDF for weight when combining all MI NWR bird groups (from Table 2) throughout the year. Again, the weight distribution for all bird groups combined resembles a Weibull Curve. The occurrence of birds greater than 3 pounds from April through September flattens the distribution,

TABLE 1. Quarterly Distribution of Bird Weights at MI NWR.

WATERFOWL POPULATION N=311,900

Weight Class(Lbs)	Jan-Mar	Apr-Jun	Jul-Sep	Oct-Dec	Annual
1.0	0.0836	0.1277	0.5547	0.0621	0.08104
2.0	0.7408	0.6915	0.1434	0.7481	0.73486
3.0	0.1753	0.1808	0.3015	0.1896	0.18383
4.0	0.0003	0.0000	0.0004	0.0001	0.00023
6.0	0.0000	0.0000	0.0000	0.0000	0.00000
>6.0	0.0000	0.0000	0.0000	0.0001	0.00003

RAPTOR POPULATION N= 3,387

Weight Class(Lbs)	Jan-Mar	Apr-Jun	Jul-Sep	Oct-Dec	Annual
1.0	0.4741	0.1842	0.0710	0.4060	0.34928
2.0	0.1034	0.0614	0.0772	0.0855	0.08562
3.0	0.0233	0.1023	0.1235	0.0744	0.06761
4.0	0.2888	0.5048	0.4537	0.3248	0.36374
6.0	0.1034	0.1364	0.2469	0.1026	0.12400
>6.0	0.0069	0.0109	0.0278	0.0068	0.00974

WADER/SHOREBIRD POPULATION N= 96,285

Weight Class(Lbs)	Jan-Mar	Apr-Jun	Jul-Sep	Oct-Dec	Annual
1.0	0.6405	0.6804	0.7126	0.6301	0.66345
2.0	0.0636	0.0274	0.0313	0.0587	0.04648
3.0	0.1529	0.1279	0.1341	0.1528	0.14281
4.0	0.0794	0.0365	0.0670	0.0745	0.06543
6.0	0.0199	0.0434	0.0257	0.0205	0.02674
>6.0	0.0437	0.0845	0.0293	0.0634	0.05510

TABLE 2. Cumulative Weight Distributions for MI NWR Birds.

Weight Class(Lbs)	Jan-Mar	Apr-Jun	Jul-Sep	Oct-Dec	Annual
1.0	0.16287	0.54988	0.67950	0.15244	0.21950
2.0	0.64331	0.16987	0.04990	0.63682	0.56848
3.0	0.17127	0.13849	0.16092	0.18310	0.17328
4.0	0.01307	0.04067	0.06093	0.01386	0.01848
6.0	0.00340	0.03650	0.02421	0.00387	0.00728
>6.0	0.00608	0.06459	0.02454	0.00991	0.01299

indicating that heavy birds make up a higher percentage of the total population. Most of the duck population has left by early spring leaving the heavier raptors to dominate more of the population.

<u>Bird Avoidance Model</u>

In 1981, the University of Dayton Research Institute (UDRI), under contract from the BASH Team, developed and implemented the Bird Avoidance Model (BAM). BAM quantifies birdstrike risk as a function of mission profile, route-of-flight, date, time of day, and aircraft frontal area (References 6 and 7). The original purpose of the BAM was to compare low-level flight routes on the basis of bird risk to allow flight scheduling to avoid the worst hazards. It would also enable route planners to redesign flight segments to minimize the risk of birdstrikes. This study is the first application of the model to characterize bird weight distributions.

Birdstrike risk is defined by BAM as the number of birds that will be encountered along a flight route during a particular mission. BAM uses latitude, longitude, and segment altitude to calculate birdstrike risk on each segment. The risks are summed over all segments to give the total birdstrike risk for the entire route. BAM allows the user to compare routes/route segments based on an expected number of birdstrikes for each mission or per mile.

The BAM results are shown as the number of expected birdstrikes per flight for each week and for each daily period. BAM output also offers the option of a segment-by-segment summary and a breakdown of the effect of local and migratory movements of waterfowl or raptors.

The BAM contains exhaustive data on waterfowl refuges, migration, breeding grounds, and raptor concentrations in the contiguous 48 states. Originally, BAM was based solely on waterfowl populations and their migrations. Quantifiable data on raptor populations and movements and breeding populations of waterfowl were included in BAM in 1985.

The BAM assumes a uniform distribution of birds within a standard radius of known congregation points such as breeding grounds or wildlife refuges. For example, the model uses a maximum population of 155,000 waterfowl at MI NWR to calculate birdstrike risk. However, monthly censuses conducted by USFWS personnel there show an annual average waterfowl population of over twice that amount (311,900). This contradiction is due to the fact that almost half the MI NWR population consists of coots. BAM uses only duck, goose and swan data to estimate waterfowl hazards. Because of their high numbers, coots were included in analysis by multiplying the waterfowl results by a factor of two.

Shuttle Operations

To assess the birdstrike risk to Shuttle operations, it is necessary to know the distribution of birds along the flight path. The Shuttle uses the same approach window (airspeeds and procedures) for each landing. However, the bird populations and their habits are quite different at each operational site.

The estimate of birdstrike risk is a function of the number of birds within a volume defined by the frontal area swept along the length of the flight route. The frontal area is the square footage of a component/aircraft as it approaches head-on. For the Shuttle, the frontal area varies from 768.7 to 944.1 square feet corresponding to 3 to 8 degrees nose-high attitude. For this analysis, the nominal 5 degrees (818 square feet) was used. This corresponds to the area subtended by the wings, nose and fuselage of the Shuttle.

The BAM calculates the number of birds expected for any segment -as defined by geographic coordinates and base altitude- of a standard or user-defined flight route. In this analysis, a typical Shuttle approach was constructed for the SLF with information provided by a 1974 BASH study (Reference 1) and Ms. Karen Edelstein (NASA). The Shuttle intercepts a 19-degree glide angle at 12,600 feet AGL approximately 6 miles from the runway and flies to a point 1700 feet AGL and 8,000 feet from the runway where it intercepts a 1.5- degree glide slope until touchdown. The final approach was broken into a series of segments based on nominal altitudes at the end of segment. The geographic coordinates for each segment were approximated from a 1:2,000,000 map.

BAM RESULTS

BAM estimates include the effects of both waterfowl and raptors but not wader/shorebird populations. It would be inappropriate to combine wader/shorebird population data with either bird category because their habits are so different. However, an estimate based only on bird population levels at MI NWR throughout the year would indicate that wader/shorebird hazards would be intermediate between the other two groups and would vary between 1 to 3 hazards per 1000 Shuttle approaches.

Separate BAM estimates were obtained for waterfowl and raptors to better show the size distribution effects attributable to each population. Waterfowl risks were multiplied by two to correspond with the increased waterfowl populations exhibited by the MI NWR censuses. Each risk was multiplied by the proportion of the MI NWR population of a particular size class (see Table 2) during a certain quarter. For example, the risk of hitting a raptor in week 14 was multiplied by the probability that the raptor would weigh 3 to 4 pounds (from Table 1) for that period (week 14 is in the Apr to Jun quarter). The total weekly risk for the SLF was determined by summing waterfowl and raptor risks over all periods.

The highest level of risk occurs in the first and last quarter of each calendar year. When plotted (Figure 3), the resultant risk estimates show levels of bird activity and the size relationships of expected birdstrikes. This graph indicates that the most serious birdstrike hazards at the SLF occur in the last quarter of the year when almost 5 of every 100 shuttle flights will impact a bird weighing 1 to 2 pounds and 1 of every 100 will weigh 2 to 3 pounds.

Figures 4 and 5 show the individual effects of waterfowl and raptors, respectively. Two- and three-pound waterfowl present the most risk to Shuttle operations at the SLF at levels almost three orders of magnitude higher than raptors. However, during the summer months, 4-pound raptors comprise the prevalent bird hazard.

Figures 4 and 5 also indicate that the waterfowl hazard is much more predictable than the raptor hazard. This suggests that waterfowl hazards are avoidable.

Relative Birdstrike Risk

Since bird census data were not available for the Edwards AFB and Vandenberg AFB, California, their bird weight distributions were not determined. However, a comparison between the three sites was possible, using the BAM risk estimates. No mathematical manipulations were made to bring the bird population estimates up to current census levels. (Remember, the waterfowl risks for the SLF were doubled in Figures 3 and 4 to include coots. The estimated risks were plotted to show relationships.

Figure 6 shows that KSC and Edwards have roughly the same timing of birdstrike risk; the greatest risk occurs in the fall which is roughly twice the risk of the springtime. A breakdown of the birdstrike risk for each site by period of day, with minor differences, shows essentially the same trends (Figures 7 through 9). Birdstrike risks at midday are approximately half those in early morning or evening. Comparisons of waterfowl risks can be made when additional population data are available from the California sites.

BAM estimates for raptors can be compared directly between the three landing sites (Figure 10). There is no nighttime risk of hitting a raptor since they are diurnal and are not known to migrate at night. It is important to note that there is twice the chance of hitting a raptor in the late summer and early fall at Vandenberg as at either the SLF or Edwards.

DISCUSSION

Based on the BAM analysis, the Shuttle can expect to hit at least two birds in every 100 approaches at either KSC or Edwards and one bird in every 200 approaches at Vandenberg. This level of birdstrike hazard is due to the relatively large proportion of waterfowl in the nearby bird populations and is the most intense

during the fall migration and subsequent overwintering each year.

Waterfowl typically migrate at altitudes below 5,000 feet AGL and are most likely encountered at altitudes below 500 feet AGL during local movements; e.g., when engaged in feeding activities around refuges. They tend to travel in flocks and fly directly between resting areas and feeding sites. Waterfowl are frequently involved in multiple birdstrikes (more than one bird at a time) with USAF aircraft.

Large birds can cause serious damage to aircraft. A 4-pound bird will release 15,928 foot-pounds of energy when struck at 300 knots. The risk of hitting a 4-pound raptor ranges from about one in the summer to six in the fall for every 10,000 approaches at the SLF and Vandenberg, respectively. Raptor populations comprise a relatively small part of the birdstrike risk at all landing sites but the hazard may be greater to the Shuttle because of their large size and soaring behavior. Their flight paths are erratic and may reach thousands of feet in the air creating problems at the higher Shuttle approach altitudes and speeds.

Wader/shorebird populations are not included in the BAM, (as well as other major components of typically hazardous bird populations such as gulls) so their effects on birdstrike risk at the various sites are not included in this analysis. This means that the calculated birdstrike risk estimates presented here are somewhat less than the actual risks expected, especially during the summer months when waders/shorebirds are concentrated in large nesting colonies. These two groups constitute a substantial part of the birdstrike hazard at KSC in the summer months (Reference 2). For example, in 1981 nesting colonies of the Least (now called Little) Tern used the overruns of the SLF, creating BASH problems for aircraft. Also, sizable rookeries of wading birds are located on MI NWR and feeding movements of Cattle Egrets on the SLF airdrome create a major hazard. Large populations of gulls and extremely large birds (e.g., Brown Pelicans) could create serious hazards if ever attracted to the vicinity of the SLF.

The BAM mathematically depicts patterns of bird movement according to basic assumptions about similarities of flight habits; i.e., what a certain bird population is doing at a certain moment and at what altitude they are doing it. Since the BAM makes no distinction other than numbers of birds found at certain altitudes during certain periods, it is possible to include taxonomically diverse groups of birds in the analysis. For instance, the soaring behavior exhibited by certain waders, especially the Wood Stork, at MI NWR would create a hazard to flight similar to soaring raptors. However, including Wood Storks as a part of the raptor analysis --with the assumption that the Wood Stork flights occur in similar ways-- would only increase the estimated birdstrike risks at the SLF by approximately one birdstrike per 1000 flights for those birds 6 pounds and over.

Since this analysis is based on a frontal area of 818 square feet, an evaluation of the birdstrike risks to any component of the Shuttle, such as the windscreen, can be made. For example, if the windscreen area is 40 square feet, the birdstrike risk would be about 5 percent those depicted in the figures.

The design for the windscreen should represent the highest level of bird hazard encountered. At KSC, the chance of hitting a 2- to 3-pound duck close to touchdown ranges between 1 and 5 per 100 flights except during summer. While the probability of hitting a 4-pound bird may be numerically remote in the fall and winter each year, the warmer months offer a good chance of encountering a soaring, large (heavier than 4-pound) bird, such as a vulture or stork, at higher approach altitudes and consequently, higher airspeeds.

Operational constraints on where and when an approach may be conducted could reduce the prospect of a birdstrike; however, this could adversely affect mission accomplishment. Scheduled landings should be avoided at night during the fall migration. The raptor hazard could be avoided by scheduling daytime landings in the winter months or by early morning landings in the summer.

CONCLUSIONS

BAM results for the SLF show that as much as 5 percent of the shuttle approaches in the early winter months would encounter a 2-pound bird while about 1 percent would involve a 3-pound bird. About one Shuttle approach in every 10,000 at the SLF would involve a 4-pound raptor. The possibility of hitting a wader/shorebird are estimated at between 1 and 3 per 1000 approaches.

Birdstrike risk to the Shuttle will be highest in the fall at all landing sites. The relative birdstrike risk (waterfowl and raptors for all daily periods) was highest at the KSC SLF during the first 2 months and last 3 months every year. The highest risks from raptors occur at Vandenberg AFB during the late summer. Nighttime risks are highest at KSC and Edwards in the early winter.

Approach birdstrike hazards are created by waterfowl at low altitudes and, to a lesser extent, by raptors at high altitudes. The raptor strikes have a higher potential for damage because of their large size and because of increased Shuttle speeds at high altitudes. Some soaring waders could create a hazard similar to raptors.

Missions could be scheduled to avoid the highest birdstrike risks normally found during migratory periods. Other bird control techniques could be used in conjunction with bird avoidance procedures to reduce the probability of birdstrike to the Shuttle.

Integration of information on population levels of waders/shorebirds and gulls (including nesting colonies and feeding movements) would enhance the BAM's capabilities to predict birdstrikes and the weight distribution of those birds involved.

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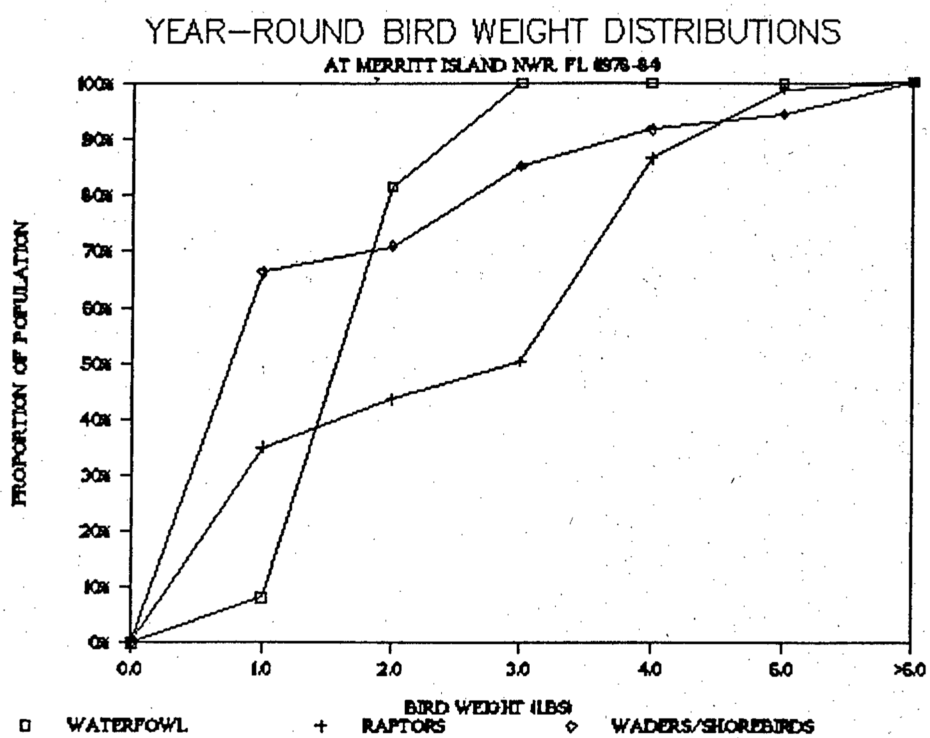
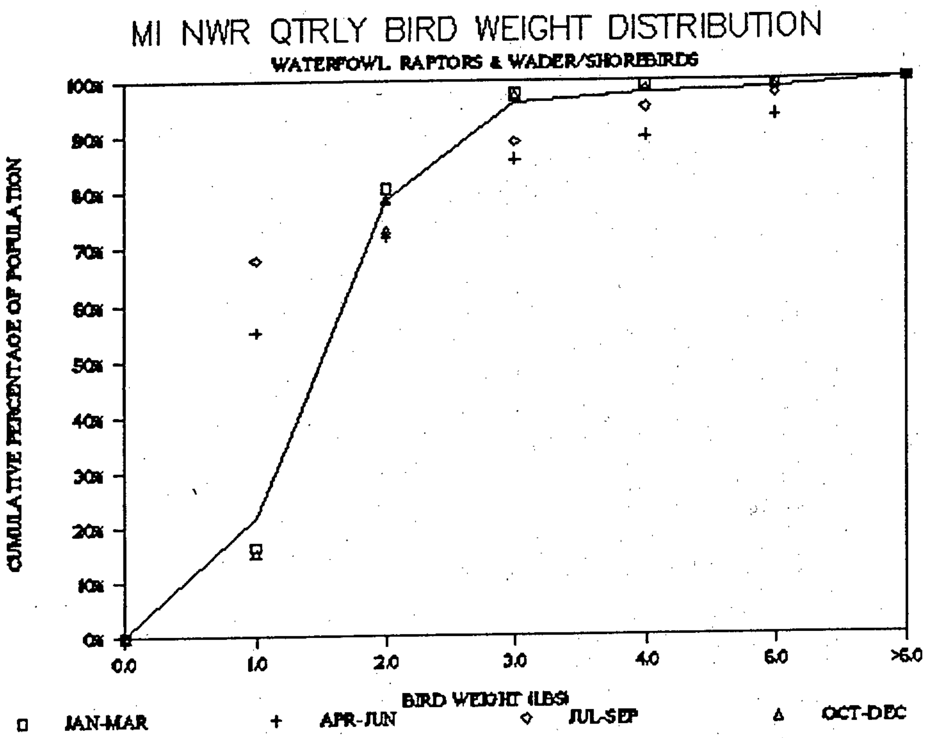
FIGURE 1



YEAR–ROUND BIRD WEIGHT DISTRIBUTIONS
AT MERRITT ISLAND NWR FL 1978-84
PROPORTION OF POPULATION
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0.0
1.0
2.0
3.0
4.0
5.0
>5.0
BIRD WEIGHT (LBS)
WATERFOWL
RAPTORS
WADERS/SHOREBIRDS

FIGURE 2



MI NWR QTRLY BIRD WEIGHT DISTRIBUTION
WATERFOWL, RAPTORS & WADER/SHOREBIRDS
CUMULATIVE PERCENTAGE OF POPULATION
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0.0
1.0
2.0
3.0
4.0
6.0
>6.0
BIRD WEIGHT (LBS)
JAN-MAR
APR-JUN
JUL-SEP
OCT-DEC

FIGURE 3. KSC SLF BIRDSTRIKE RISK

WATERFOWL AND RAPTORS FOR ALL PERIODS

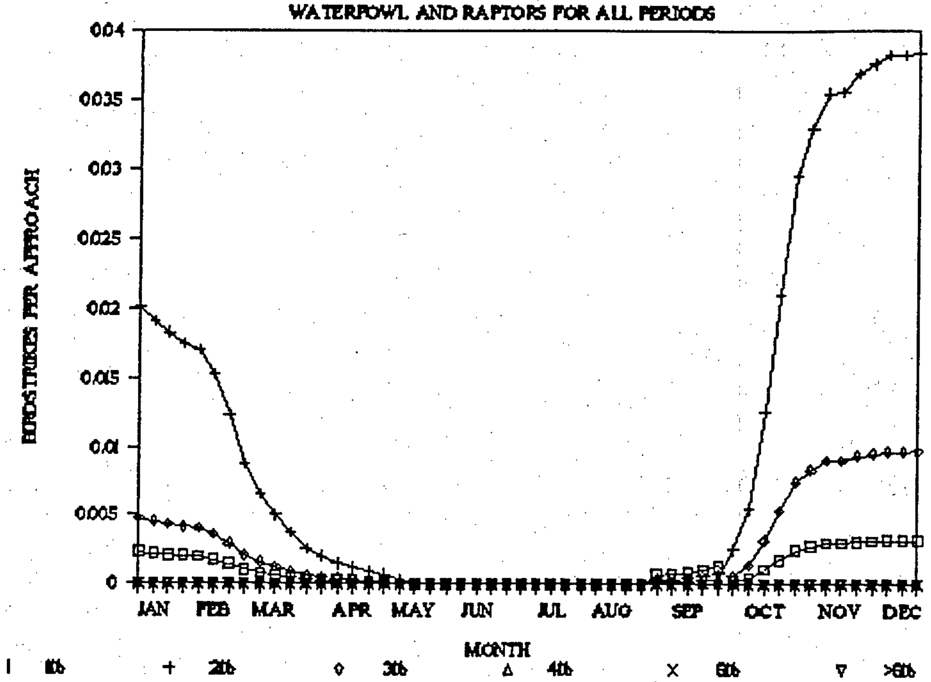


FIGURE 4. KSC SLF WATERFOWL RISK

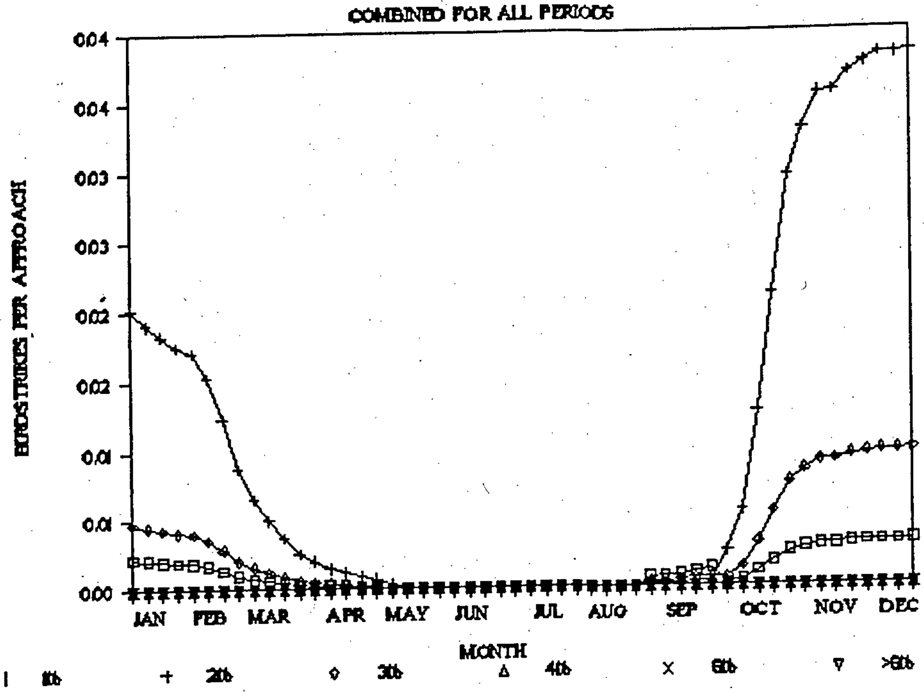


FIGURE 5. KSC SLF RAPTOR RISK

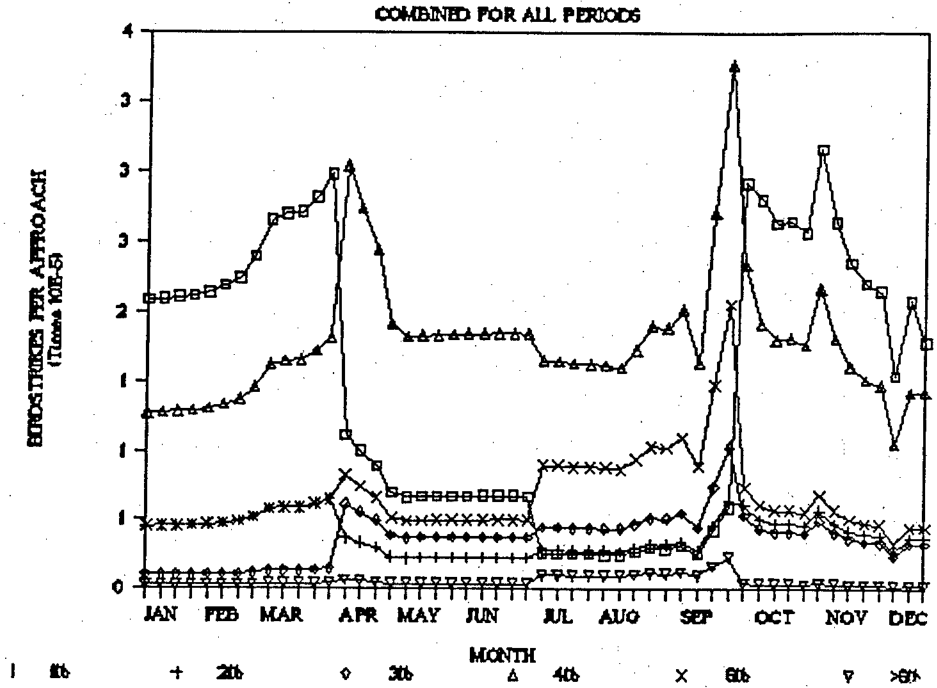


FIGURE 6

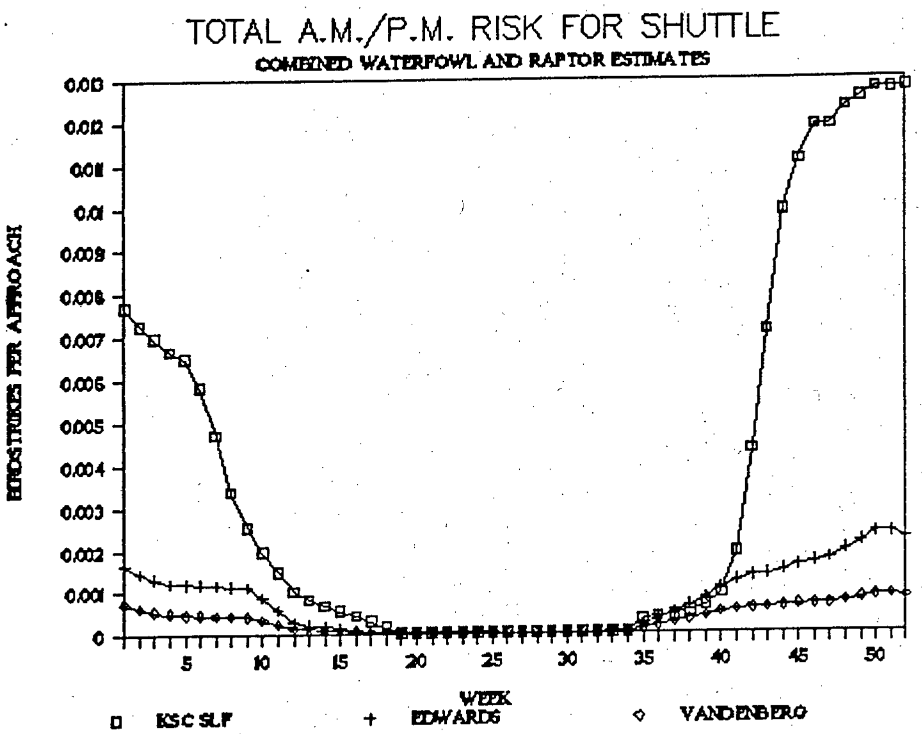

TOTAL A.M./P.M. RISK FOR SHUTTLE
COMBINED WATERFOWL AND RAPTOR ESTIMATES
BIRDSTRIKES PER APPROACH
0.013
0.012
0.011
0.01
0.009
0.008
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0
5
10
15
20
25
30
35
40
45
50
WEEK
KSC SLF
EDWARDS
VANDENBERG

FIGURE 7

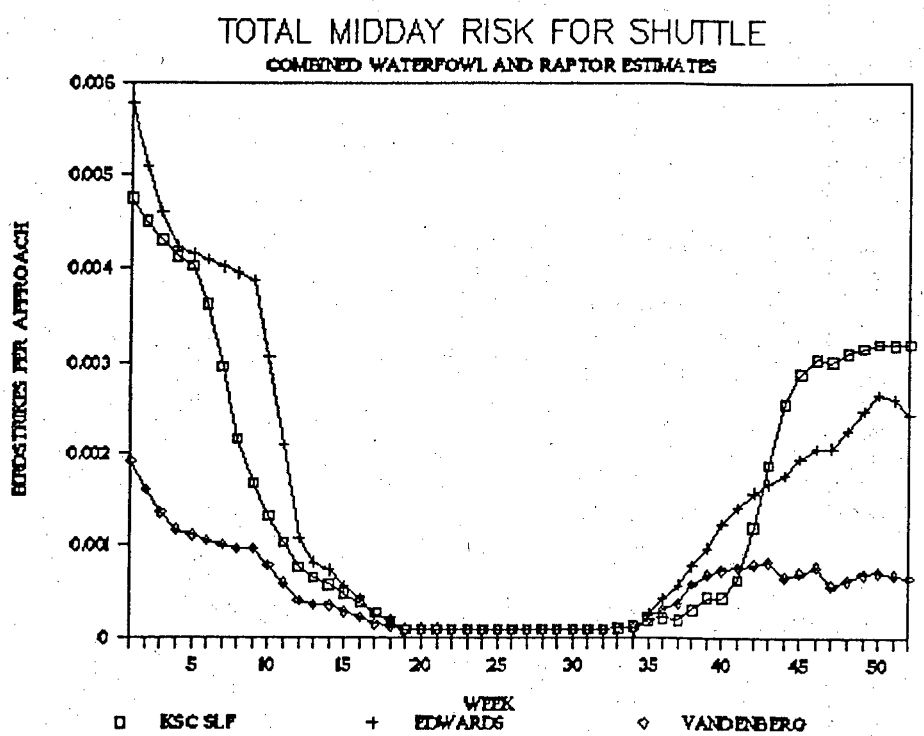

TOTAL MIDDAY RISK FOR SHUTTLE
COMBINED WATERFOWL AND RAPTOR ESTIMATES
BIRDSTRIKES PER APPROACH
0.006
0.005
0.004
0.003
0.002
0.001
0
5
10
15
20
25
30
35
40
45
50
WEEK
KSC SLF
EDWARDS
VANDENBERG

FIGURE 8

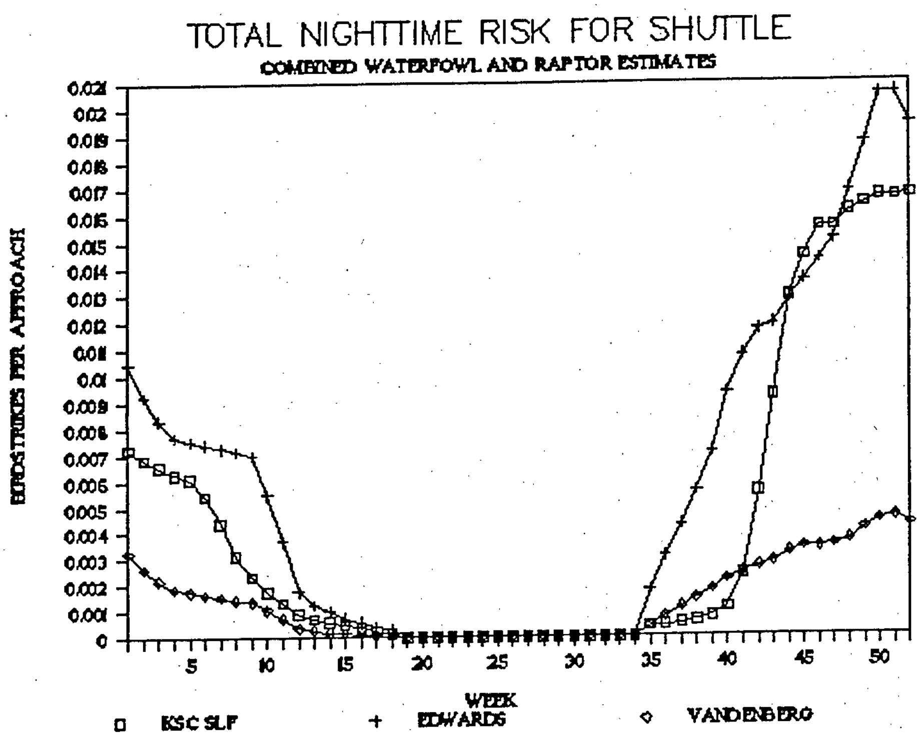

TOTAL NIGHTTIME RISK FOR SHUTTLE
COMBINED WATERFOWL AND RAPTOR ESTIMATES
BIRDSTRIKES PER APPROACH
WEEK
KSC SLF
EDWARDS
VANDENBERG

FIGURE 9. RELATIVE BIRDSTRIKE RISK

COMBINED WATERFOWL AND RAPTOR ESTIMATES

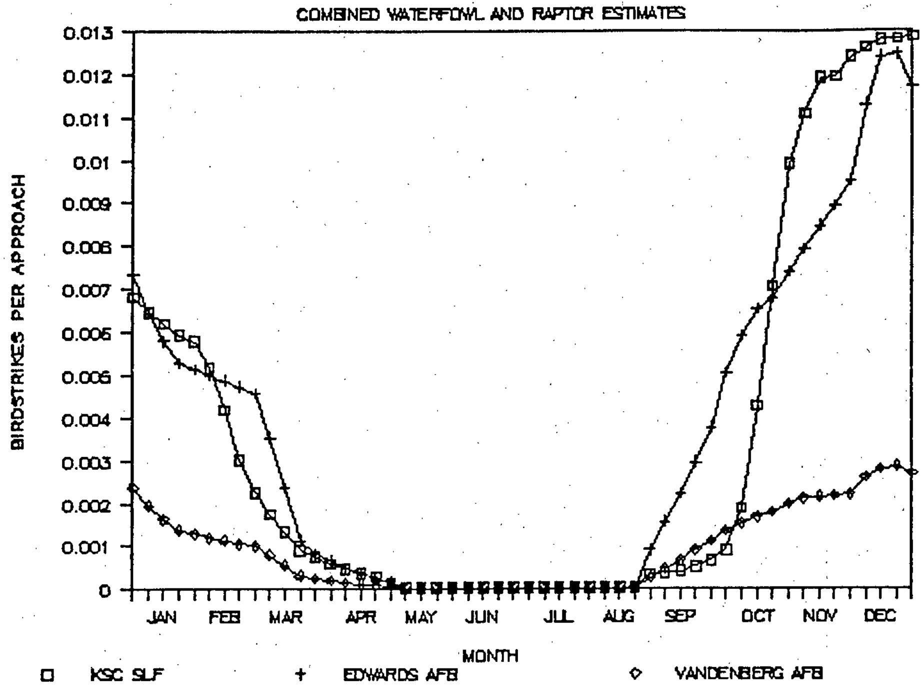
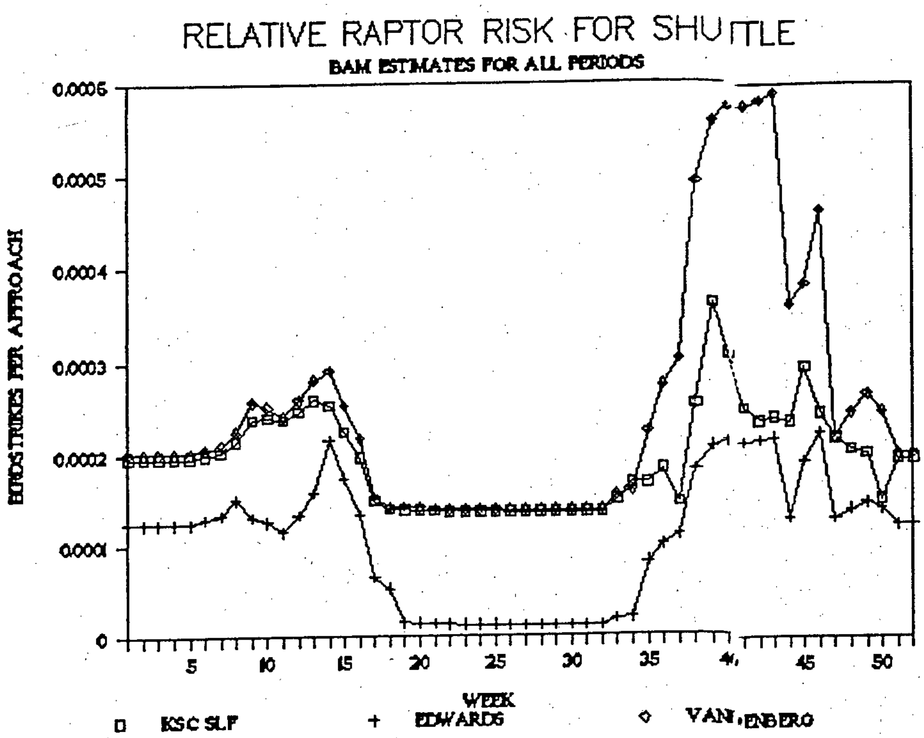


FIGURE 10


RELATIVE RAPTOR RISK FOR SHUTTLE
BAM ESTIMATES FOR ALL PERIODS
BIRDSTRIKES PER APPROACH
0.0006
0.0005
0.0004
0.0003
0.0002
0.0001
0
5
10
15
20
25
30
35
40
45
50
WEEK
KSC SLF
EDWARDS
VANDENBERG


Birdstrikes Happen

ADF61009

Radio-controlled bird defense system

(Stefan System) (H. Fürbeth, FRG)

BSCE 19 / WP 12

Madrid, 23-28 May 1988

RADIO-CONTROLLED BIRD DEFENSE SYSTEM (STEFFAN SYSTEM)

by Dr. H. Fürbeth, Schlangenbad

There are a number of measures to prevent bird strikes in air traffic. However, measures to chase off birds, technical measures such as bird traps, different kinds of scarecrows, pyro-technical bangs, ultra-sounds and electro-magnetic measures all turn out to produce little because they lack the striking power of the immediately effective operations.

The Steffan System can, due to its radio-control, be put to operation wherever birds settle or approach. Accustomization is impossible as the acoustic irradiation does not work prophylactically but only when specific dispersal is necessary. The Steffan System is used in civil and military areas.

The Steffan System consists of a central transmitter, which can, according to requirements, be installed in the tower or in the fire-station, and of a number of detonators triggered individually or in groups. The power supply system is based on a main circuit connection. Each of the detonators requires an acetylene gas container which services 8.000 to 10.000 rounds. The pressure supply of the Steffan System is provided by a leadplate battery with a solar cell. Inspection and maintenance is necessary every four to five years.

In the history of mankind man has always felt the acute need to expel birds as competitors four nourishment. In this attempt different methods were employed. Most effective was, at all times, the banishment by means of sound bursts with a high accoustic intensity, of noises intended to cause fright - from the clapping of hands to pyrotechnical explosions. As far as the effectiveness of the banishment was concerned the immediacy of the acoustic procedures rather than the frequency spectres played the decisive role.

In the course of the advancement of technical achievements the fright-intensive acytelene gas explosion with its semi - automatic sound devices - together with many other methods - increased in order to protect valuable agricultural areas. In vineyards and other special cultural areas the so-alled carbide detonators were widely spread. These devices were, however, more or less locally restricted and thus effective only in a narrowly limited area. They demanded constant inspection and maintenance and consequently required immense personnel; above that they caused considerable annoyance to the populated environment because their operation covered large spans of time. As the devices were constructed for permanent employment the birds after some time got used to the acoustic disturbances. All installations operating on a permanent basis are known to produce such accustomizations. This applies to optical devices (scarerows) as well as to electro-acoustic or pyro-technical implements. The DAVVL pointed that out in a statement issued on March 15, 1987. Therefore, in order to avoid bird accustomization, the employment of detonator-, lightning-, and whistling-cartridges had to be arranged in changing positions, preferably in permanently changed locations as well. In the past one attempted - mostly without success - to avoid bird accustomization by positioning detonators where bird flights commonly appeared or where they preferred to settle; the position and the firing frequency of those devices was permanently altered and newly adjusted to the frequency spectrum of the birds' critical range of audibility. Attempts with infra-- or ultra-detonators and frequency modulation used in larger areas turned out to guarantee no permanent and comprehensive success; the same applies to optical devices. Effects to disperse birds and intimidate them through such measures proved less strong than instinctive bird behaviour.

Only by introducing a radio-controlled, locally and temporally independent pyro-acoustic combination of devices operating network-

free - the Steffan System - could the disadvantages of all previous system at once be eliminated. The system was developed for wine growing; for twelve years it has been successfully employed in large wine growing areas in times of grape ripening.

Since the air-crash of a US military plane in 1984 caused by bird strike the Steffan System has been in operation on military and civil airfields. It turned out that the Steffan System, constructed to disperse birds from airfields or parts of airfields, was particularly successful where measured applied by the biotope management did not work or were ineffective on account of reasons relating to servicing techniques or to phenology. This can be case where - even if only temporarily - unfavourable biotope situations near airfields can not be changed or when the agricultural utilization in the critical enviroment can not be adjusted to the demands of airfield ecology due to important reasons.

In spite of the efforts of the biotope management there are, in times of increased bird activity, frequent and sudden bird gatherings on airfields causing considerable dangers to air traffic. The Steffan System is a useful complement of the efforts of the biotope management; it is <u>indispendable</u> where ecological measures to free air traffic systems and their critical environment from birds fail so that grave dangers to air traffic and passengers can not beruled out. This applies particularly to to airfields in agricultural areas, near shores, near natural anthropogenic waters, and near special damp areas. Additionally, the existance of dumps near airfields, particularly in starting and landing areas, can definitely necessitate the installation of the Steffan System.

A considerable number of examples in the application of the system both in military and civil air traffic has shown that the use of Steffan System on airfields and other areas freed those sites from birds even under complicated conditions thus meeting both the practical requirements in air traffic and legal demands in a satisfactory way. Legal matters are particularly important when damages or even accidents lead to compensation claims.

The Steffan System consists of a centrally operated radio-controlled transmitter. The number of detonators depends on the site and on the degree of danger. They also depend on previous bird observation, on the experience of the local experts, on scientific criteria and, if occasions arise, on the principles and recommendations

of biotope expertise. The detonators can also be installed in critical areas.

The detonators are triggered individually or in groups by way of a radio impulse according to existing dangers: the dispersing bangs effect only those parts of the airfield where birds are about to approach or where they have already settled. Precise dispersion eliminates practically all birds from airfields within a few minutes. Even bird flights returning more than once can be dispersed thoroughly through the dynamics of the radio-controlled operation. The operation of the Steffan System is engineered centrally under strict observance of a previously established operating strategy based on the specific ecological situation, previous tests related to bird observation, on local criteria of air safety, and on a thorongh discussion with airfield personnel. It is part of the delivery agreement. It is particularly relevant to consider the flight behaviour of the birds. This phenomenon can be succesfully influenced by the Steffan System because there are no human beings on the local site and because the dispersion is both precise and specific thus influencing the flight direction. The operational strategy guarantees that individual birds or even flights of birds are not driven in the area of starting or landing airplanes - a categorical demand which, by the way, universally applies to all methods of bird dispersion.

The central control, the sender, should for practical reasons be installed stationary; its operation should be coordinated with air traffic control, the police, and other safety organs. In case of dangerous situations it should be left to the bird strike expert and to the apron services to request the triggering of the local detonators by radio control. Services thought of in this context are the fire-brigade and traffic and security organs. The operation be means of central control from the tower or from any other central locality is also practicable in poor visibility.

an important factor is noise disturbance. It is relatively small because noise emissions produced by the system are below the noise level an air fields and because the operation producing noises is partially restricted, often effecting only those areas where danger is about to arise and where flights of birds approach. Airfields working with the Steffan System according to the operational strategy have articulated no complaints concerning the reduction of the system.

Finally some technical details:

The Steffan System consists of a central control and, depending on the operating range, of a number of detonators triggered individually or in groups. Each detonator has four pipes so that the detonation produced is fourfold (Quattro-Bang). The system is operated by one person at the central control. The triggering of the individual devices or of groups of detonators follows the entering of the code and the radio signal. Then, within six seconds, the following control sequence takes place:

1. The reception of the signal
2. Transmitting time of impulse and automatic control service of the electronic data
3. Ingress of gaseous mixture into the firing chambers
4. Ignition and triggering of the Quattro-Bang (transposed time: 1 - 3 - 2 - 4; the frequency is variable)
5. System is released for further triggering.

The transmitting time of the impulse can be adjusted in a way that the triggering of one group produces a 'running fire effect'. The power supply system is based on a main circuit connection. As to the detonators, for each of them one acetylene gas container is required; it services 8.000 to 10.000 rounds. The pressure supply is provided by a leadplate battery with a solar cell. Maintenance checks are necessary every four to five years. Inspection and maintenance can be taken care of by qualified airfield personnel.

Translation Dr. Michael Stein

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Following soaring bird migration from the ground, motorized glider and a radar at a junction of three continents

(Y. Leshem, Israel)

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FOLLOWING SOARING BIRD MIGRATION FROM THE GROUND, MOTORIZED GLIDER AND RADAR AT A JUNCTION OF THREE CONTINENTS

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ABSTRACT

The geographical position of Israel at the junction of three continents is responsible for its importance as a focal point for the largest concentrations of soaring birds (raptors, storks and pelicans) during spring and autumn migrations.

The purpose of the research work conducted in Israel was to map the migration routes of a number of species, to learn about the flight altitudes and velocities and to study and analyze the extent to which the above variables, as well as the routes themselves, are influenced b weather conditions, time of day and time of year.

Three data-gathering systems were employed in conjunction: a network for ground observation crews, a motorized glider and two radar systems - one at Ben Gurion International Airport and the second a meteorological radar system. The data thus gathered produced a clear picture of the geographical positions of the migration routes, the altitudes, velocities and daily progress of the migration, and its relation to changes in weather conditions.

The Israel Air Force sustainded heavy damage to its aircraft as a result of collisions with migration soaring birds. Recognizing this, it provided the financing for this research. The data collected and analyzed were submitted to the IAF, which ceased flying at the times, routes and heights at which migration occurs. Consequently, no planes have been destroyed or seriously damaged over the past five years (1983-1987).

INTRODUCTION

The location of Israel at the junction of three continents - Europe, Asia and Africa - has made it part of a migration route of international importance in spring and autumn.

For most soaring birds, large water bodies, such as the Mediterranean, the Caspian or Black Seas, are barriers which must be circumvented on their way from Asia or Europe to Africa. The population of Western Europe concentrates in the area of the Gibraltar Straits; a small part of the Central European population crosses the Mediterranean at its narrowest points, such as Italy and Sicily; the major part of the North, Central and Eastern European populations as well as large parts of the Western Asian and Caucasian populations fly along the shortest route, around the Mediterranean, concentrating in the skies of Lebanon, Israel and Egypt on their way to Africa.

During the last decade there has been significant progress in studying the phenomenon of soaring bird migration over Israel. From the various surveys held it is now clear that Israel is one of the best places in the world, if not the best, to watch migration soaring birds.

During the spring of 1985 1,193,751 birds of prey were counted over the Elat mountains (Shirihai, 1986). In autumn 1985 556,824 raptors were counted at Kfar Qasem (Dovrat, 1986). The data of Shirihai (1987), Leshem (1984), Christensen et al (1981), Bijlisma (1982), Wimpfheimer et al (1983) and Dovrat (1984,1985) confirm the information on the large numbers of soaring birds which pass over this area in spring and autumn.

After working for several years with ground crews surveying migration it had become clear to us that the data was incomplete due to the limitations of the system used. Ground crews are not able to estimate exactly the altitude of migration and cannot see above a certain height.

As a result we decided to approach the Israel Air Force and suggest a joint program where we will pass on to the IAF all migration data gathered up to now, to warn them of impending damage by migrating birds. The Air Force in turn would provide a light aircraft to be used in locating major migration routes, altitudes and behavior of the birds, which would complement the limited information from ground crews.
When we first contacted IAF officers, at the end of the 1983 spring migration, it became clear, to our astonishment, that the conflict between IAF fighter planes and migrating birds was far beyond what we had imagined. Every year there were dozens of collisions between aircraft and migrating soaring birds. When the number of these collisions between the years 1972-1982 was totaled, it reached into the hundreds, with cases in which fighter planes crashed and pilots where killed. The financial loss was tens of millions of dollars.

Table 1

It is clear from this data that most of the collisions occur during the spring (March-May) and autumn (September-October) migration seasons. The concentration of millions of migrating birds along with hundreds of military aircraft in the limited airspace over Israel would inescapably cause a large number of collisions. To understand the enormity of the danger it is enough to know that an airplane flying at a speed of 800 kilometer per hour colliding with a Kite weighing 900 grams is hit with a force of 22.5 tons, a Griffon Vulture with a force of about 40 tons and a Pelican weighing more than 7 kilograms will hit an aircraft with a force of about 100 tons.
In order to reduce the number of aircraft - bird collisions a study was started to define migration routes, altitudes and times of the major species and their relation to changes in weather. This data would then be used to prevent flying at certain times and in certain locations.

METHODS

1. Ground crew surveys to achieve maximum area coverage: a network of ground crews following migration at major passage points in Israel. The network was based on several volunteer birdwatchers (up to 150 in autumn, Kfar Qasem Survey), who were spread over 14 observation point covering the country from Tel-Aviv to the Mediterranean coast in the west to the Jordan Valley in the East (see map 1). The observers had radio transmitters for communicating to prevent overlapping in counting. In some cases mobile observation points were set up with vehicles to keep up with the changing migration axis during the day.

Map 1

2. Following migration with a motorized glider: after 19 flight days with a military light aircraft (Cessna) we realized that although these flights helped locate several major routes, the flight speed was too great to permit tracking of single flocks. The aircraft was sufficient for days with migration "floods", but was not appropriate for days with less migration. We then started looking for a smaller, slower aircraft which would help us complete our data. Hang gliders were checked, but they were good only for localized tracking and not for longer flights. The "Ultra-Light" a motorized hang glider, was better, but limited to two hour flights and unstable over mountainous areas where most migration passes. We finally found a motorized glider, the OGAR, produced by PZL, Poland, which has a 65 h.p. engine and a wing spread of 18 meters. Thanks to its motor it can take off and land independently, fly about 8 hours on its engine, and by gliding part of the time, double its time in the air. (A spare fuel tank was attached to the glider, which could be refueled in flight and therefore spend this much time in the air.) The motorized glider has 2 seats, both in front. The propellor is behind the canopy and so the observers have a much wider field of vision than in light aircraft. The flocks are located in the evening at their roosting spots by mobile IRIC crews. In the morning the glider arrives at this spot about 15 minutes before the estimated time of departure. It waits at the site until the flock is in the air and then joins it directed by radio transmitters with the ground crews. The gliders instruments enabled us to track the exact migration altitude of the birds, their speed, take-off and landing time as well as counting the times the soaring birds use thermals along the way. All this while

tracking their route exactly from the time they lifted off in the morning to when they descended in the evening or left Israeli air space to neighboring countries.

Picture 1

3. Radar: The Airport Authority at Ben Gurion Airport allowed us to use a sensitive radar screen of the ASR-8 type to track and map migration. The IAF had women soldiers manning the radar during all migration seasons and they drew the exact situation as seen on the screen every 20 minutes. At the same time the screen was photographed with Polaroid cameras. The radar at Ben Gurion Airport was directed very efficiently towards the flocks and at times could continuously allow a migrating flock when the glider landed to re-fuel after several hours of flight. An additional military meteorological radar tracked migrating flocks of birds in the Negev.

RESULTS AND DISCUSSION

The observer ground crews were active each autumn migration season between August 20 - October 18, a total of 60 observation days, and in the spring between February 15 - May 20, a total of 95 days. Thus, almost every year migration was followed for more than 5 months during the period 1980-1987. The ground crew network enabled us to gather important data on several subjects: dates of passage of a specific species are usually quite constant. Honey Buzzards, *Pernis apivorus*, for example pass over each autumn in two main waves between the 3-15 September and in spring in two main waves between 3-17 May. The Levant Sparrowhawk, *Accipiter brevipes*, passes over in large waves after the Honey Buzzards, between 15-25 September and in spring, before the Honey Buzzards between the 20-30 April. The Lesser Spotted Eagle arrives in large concentrations between the 27 September - 6 October while the Steppe Eagle, *Aquila nipalensis*, arrives in spring in large concentrations betwwen the end of February to the first week in March. By using this data from the ground crews we could provide the IAF with advance warning in real time on expected large migration waves. They in turn, could then stop low altitude flights during this time.

The widespread observer network, which was equipped with radio transmitters to prevent overlap in counting, enabled us to perceive clearly (though not completely the number of raptors overflying Israel. In spring 1980 for example, 36,000 Black Kites were counted, in spring 1985 850,000 Honey Buzzards and 75,000 Steppe Eagles and in spring 1986 465,000 Steppe Buzzards. During the 1983 Kfar Qasem autumn migration survey 141,000 Lesser Spotted Eagles were counted and in autumn 1986 44,000 Levant Sparrowhawks. These counts are of value in estimating the size of certain European and Asian populations about whom only partial information exists at present.

Picture 2

We first started tracking migrating soaring birds with the motorized glider in spring 1986. This sort of tracking had already been done by Pennycuick (1972,1979). However the location of Israel at the junction of three continents and the basic information on migration routes which already existed enabled us to make 14 tracking flights already in the first year (spring 1986). In the autumn of 1986 there were 27 additional flights, a total of 41 flight days in which we followed flocks of Lesser Spotted Eagles, Honey Buzzards, Levant Sparrowhawks, Storks and Pelicans.

The flights in the glider enabled us, for the first time, to gather exact, three-dimensional data on the altitude of the migrating flocks. Data on the altitude of flight in relation to the utilization of thermals was recorded, while continuously tracking the flock from the base to the top of the thermal, and gliding altitude till the next thermal was reached. In this way movements were followed from the moment the flock took off in the morning until it landed at the end of the day or reached the border, while mapping exactly all thermals utilized along the way.

Graph 2 exemplifies a typical flight with a flock of Honey Buzzards in a three-dimensional flight altitude section. We can see that the flight was made on a day with 4/8 cumulus clouds at a cloud base altitude of 5500 feet, and moved most of the time between altitudes of 2500-5100 feet above sea level.

Graph 2

In addition to the migration altitude sections we were able to systematically track the raptor flock's route while flying alongside it for 4-11 hours a day, along the length of Israel, for distances between 38 to 311 kilometers with the same flock. This method enabled us to located important migration routes which we had not formerly known from the data provided by the ground observer crews. This information was the basis for declaring certain areas off-limits for IAF aircraft.

Map 2

The flight speed of the flocks while gliding between thermals and the final speed per hour of migration was computed. Maximum gliding speed reached 85 k.m.h. and the average velocity was 17-65 k.m.h. according to weather conditions (see p.). The average velocity of the flock is very important to the air force, as it enabled us to estimate the rate of progress of the flock, and with the help of the radar warn IAF bases in advance on the time of approach of a flock.

The glider was also useful in checking the data provided by the various radars used. We were able to check the discovery threshold of the radar, our ablility to estimate the size of a flock with it and the reliability of its coverage at different ranges.

In addition to the systematical tracking with the motorized glider, in 1986 we decided to track autumn and spring migration with the ASR-8 arrival radar at Ben Gurion Airport. By using the data from the ground, the motorized glider and the IAF light aircraft we found that the radar could spot migrating flocks of raptors at ranges of 30-40 miles. In spring 1986 about 40 flights were made in which the glider was directed to the migrating flocks by the radar. We found that the radar spotted flocks of 10 or more birds of prey. Air force equipment operated by two senior air control officers drew situation maps of the flocks every 20 minutes and simultaneously photographed the radar screen with a polaroid camera.

With the help of the radar at Ben Gurion Airport we were able to map major migration routes on a horizontal plane (it does not provide altitude data), and receive a rough estimate on the number of flocks and their size on a daily and seasonal basis. We learned that the migration axis has dynamics of its own: in the morning it moves 7-11 kilometers east of the Mediterranean coastline and towards noon it drifts 18-36 kilmeters further east to the slopes and summits of the mountain ridge which lies along the length of the country. On record migration days flocks of 20-60,000 were observed along 70-80 kilometers in one continuous mass (see photos 3,4).

The relation between climate factors and migration

From a preliminary analysis of climate data during migration it seems that meteorological factors play a major role in determining the characteristics of migration. On days when there is atmospheric instability and good thermals develop the raptors manage to "climb" higher and glide for longer distances, thereby reaching an average velocity of up to 65 k.m.h. On warm, windless days gliding conditions are bad, and there are even inversions, the raptors cannot reach high altitudes with the thermals and they migrate closer to the ground, at lower speeds between 17-30 k.m.h., with only short-distance glides between climbs. According to this data, a flock of raptors migrating on days with optimal gliding conditions, may cover a distance of 500-600 kilometers in an average of 10 hours. On days with imperfect gliding conditions it can cover only 170-300 kilometers a day.

Changes in dates of passage

On days with barometric depressions, when good gliding conditions cannot develop and rain falls, migration seems to stop almost completely or is significantly delayed. When this occurs on the way from Europe to Israel, migration waves may come several days late, and enable the IAF to add a few more flight days. One such case was the unusual depression which reached Israel this last year at the end of September.

The Number of Lesser Spotted Eagles (Aquila pomarina) that migrated over Israel during the peak week

(according to Dovrat, The TORGOS 12 and preliminary summaries)

Date/ /Season	27/9	28/9	29/9	30/9	1/10	2/10	3/10
autumn '85	7006	11133	4716	8301	2877	7373	24767
autumn '86	17859	15584	26553	12559	107	160	3407

The week between the end of September to the beginning of October is the peak week for Lesser Spotted Eagle migration. From comparisons of data from the past two years (not in absolute numbers) we see that during the first 3 days in October 1986 there was a sharp decrease in the number of migrating Eagles as compared to the previous year. A satellite map from 29/9/86 (see photo 5) shows a large barometric depression encroaching on the area from Russia, but central Turkey and southwards, Lebanon and Israel are clear of clouds. On the other hand, a satellite photo from 2/10/86 (photo 6), shows a large depression over the Middle East, which caused large amounts of rain to fall over Israel.

In these bad thermal conditions, compared to the previous year, the Lesser Spotted Eagles were detained until the depression passed. And so, finally, between 4-8 October 1986, when the depression had passed, another 22,151 Lesser Spotted Eagles passed over, compared to 11,151 in the same period the previous year.

Pictures 5 & 6

The solution for the Israel Air Force

After the data from all the different sources - ground crews, motorized glider, radar - and the relation between changes in migratory patterns to meteorological factors had been analyzed, the IFA introduced BPZ (Bird Plagued Zone) regulations. These regulations forbid fighter planes to fly during the migratory seasons at the altitudes and along

Since these regulations have been in effect there was not even one more serious collision and no aircraft or pilot were hurt or damaged. The results of this study which were implemented by the IAF have saved it millions of dollars. By financing the study the air force enabled us to carry out a widespread project to learn about one of the most impressive phenomena in nature.

Aknowledgements

Thanks to Colonel G., Lt. Colonel O. and the air force pilots whithout whose cooperation this project would never have become reality. I would also like to thank Eli Peretz, Mikhael Pinkus, Rafi Luski, Rena Levinson and all the other motorized glider pilots. Pini Magor and Asher Friedman air force radar operators and Ilana Agat from the Israel Nature Reserves Authority manned the arrival radar at Ben Gurion Airport expertly. And of course, thanks to the Airport Authority who permitted us to use the radar. Special thanks are due to Ehud Dovrat and the hundreds of volunteer birdwatchers who helped gather data from the ground tirelessly, the staff of the IRIC and the SPNI who provided the framework for the study. To Esther Lachman for helping in the translation. I am grateful to Prof. Yoram Yom-Tov of Tel Aviv University, the scientific mentor of the project, to Dr. Ian Newton and Mark Fuller for their guidance and to the Office for Science and Development, the Ecology Fund and the SPNI who helped finance the project.

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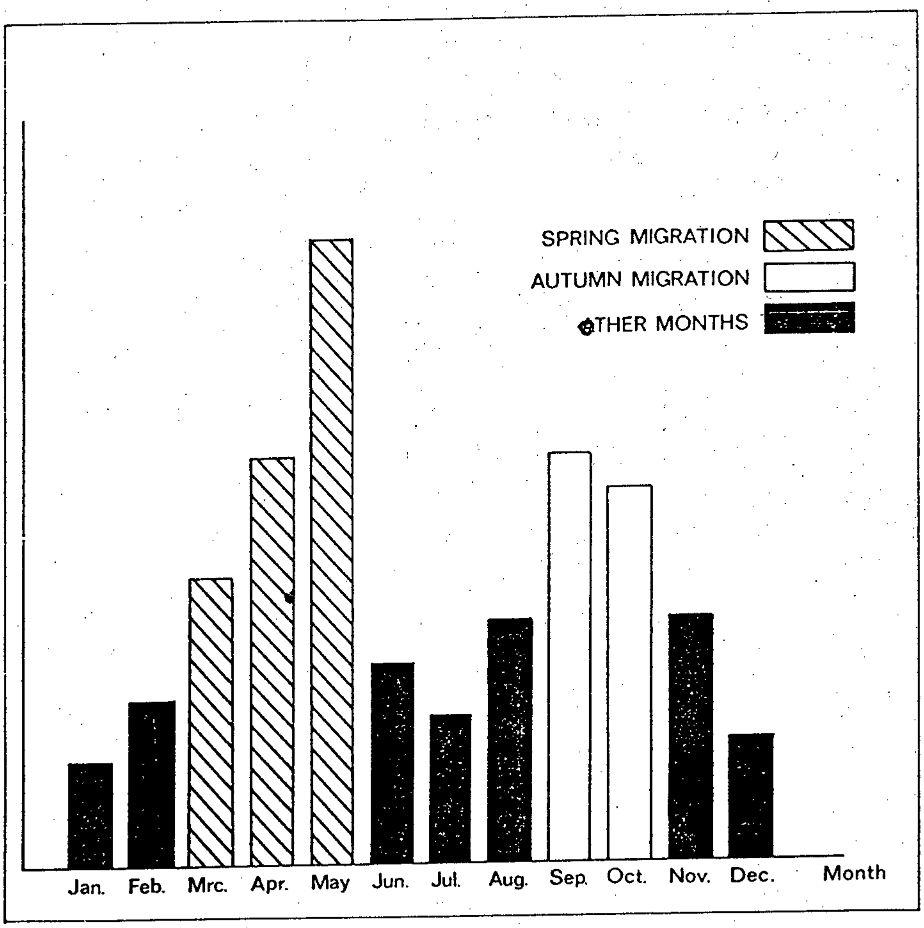
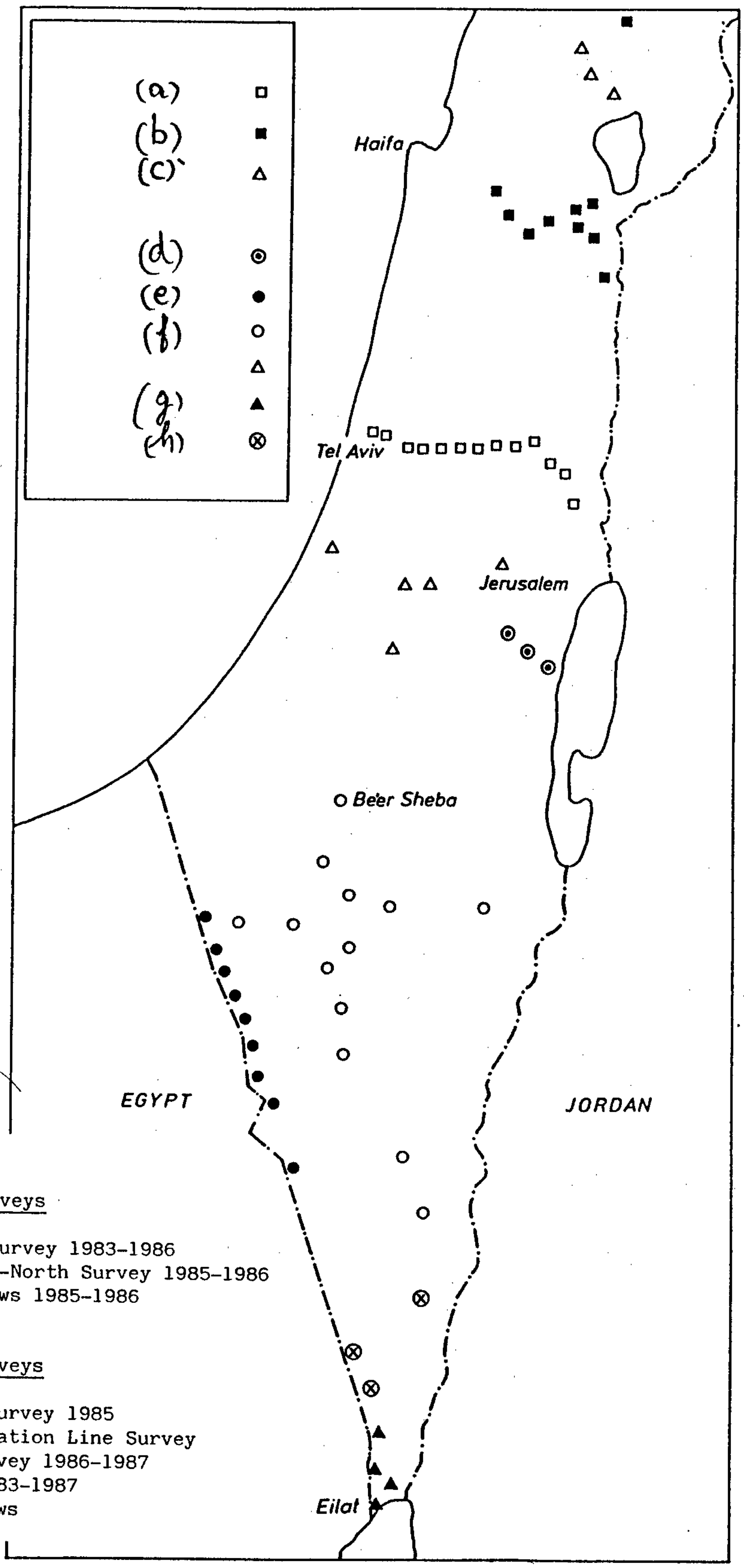
Table 1

Damage tc IAF aircraft from birds 1972-1982.
Exact numbers have been censored for security reasons, however the large numbers of collisions during the months of spring (March, April, May) and autumn (September, October) migration is evident.





Map 1

Autumn Migration Surveys

(a) Cross-Samaria Survey 1983-1986
(b) Jezre'el Valley-North Survey 1985-1986
(c) Independent crews 1985-1986

Spring Migration Surveys

(d) Judean Desert Survey 1985
(e) Egyptian Demarcation Line Survey
(f) Har Hanegev Survey 1986-1987
(g) Eilat Survey 1983-1987
(h) Independent crews

Map 2

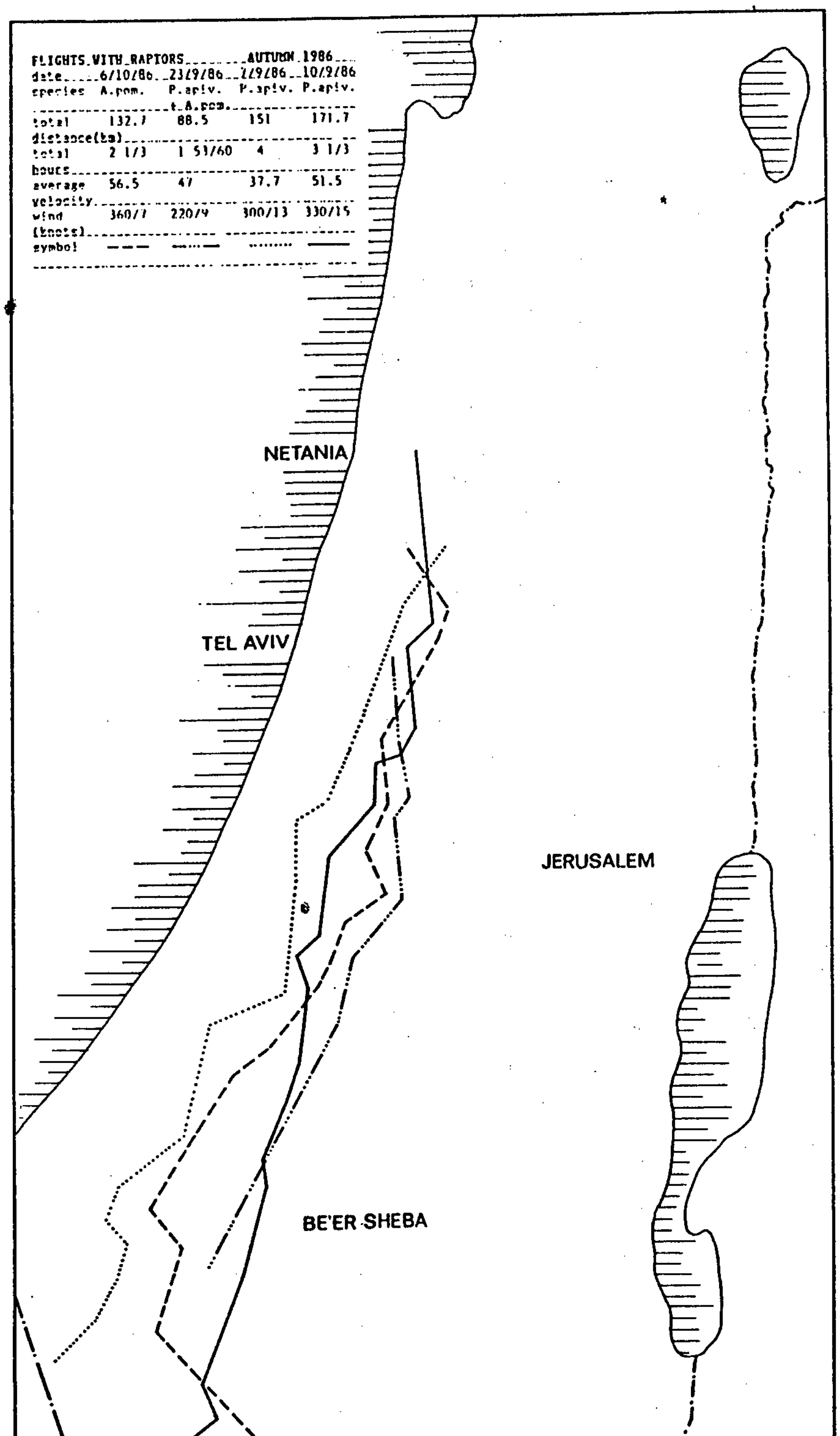

FLIGHTS WITH RAPTORS AUTUMN 1986
date 6/10/86 23/9/86 22/9/86 10/9/86
species A.pom. P.apiv. + A.pom. P.apiv. P.apiv.
total distance(km) 132.7 88.5 151 171.7
total hours 2 1/3 1 53/60 4 3 1/3
average velocity 56.5 47 37.7 51.5
wind (knots) 360/7 220/9 300/13 330/15
symbol
NETANIA
TEL AVIV
JERUSALEM
BE'ER SHEBA

Photo 1

The motorized-glider with pelicans (Photo Ofer Bahat)

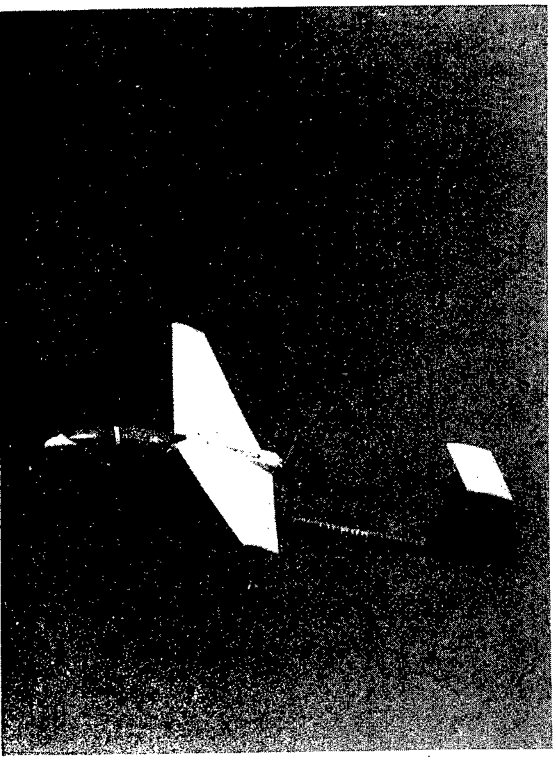
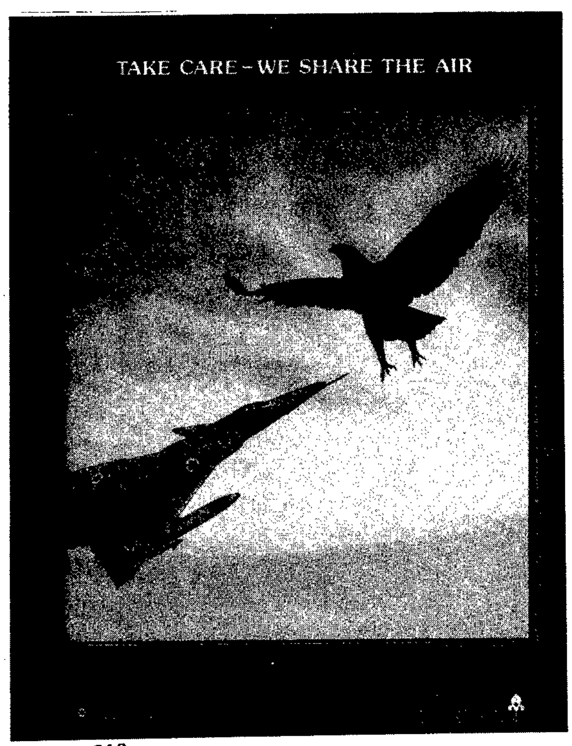


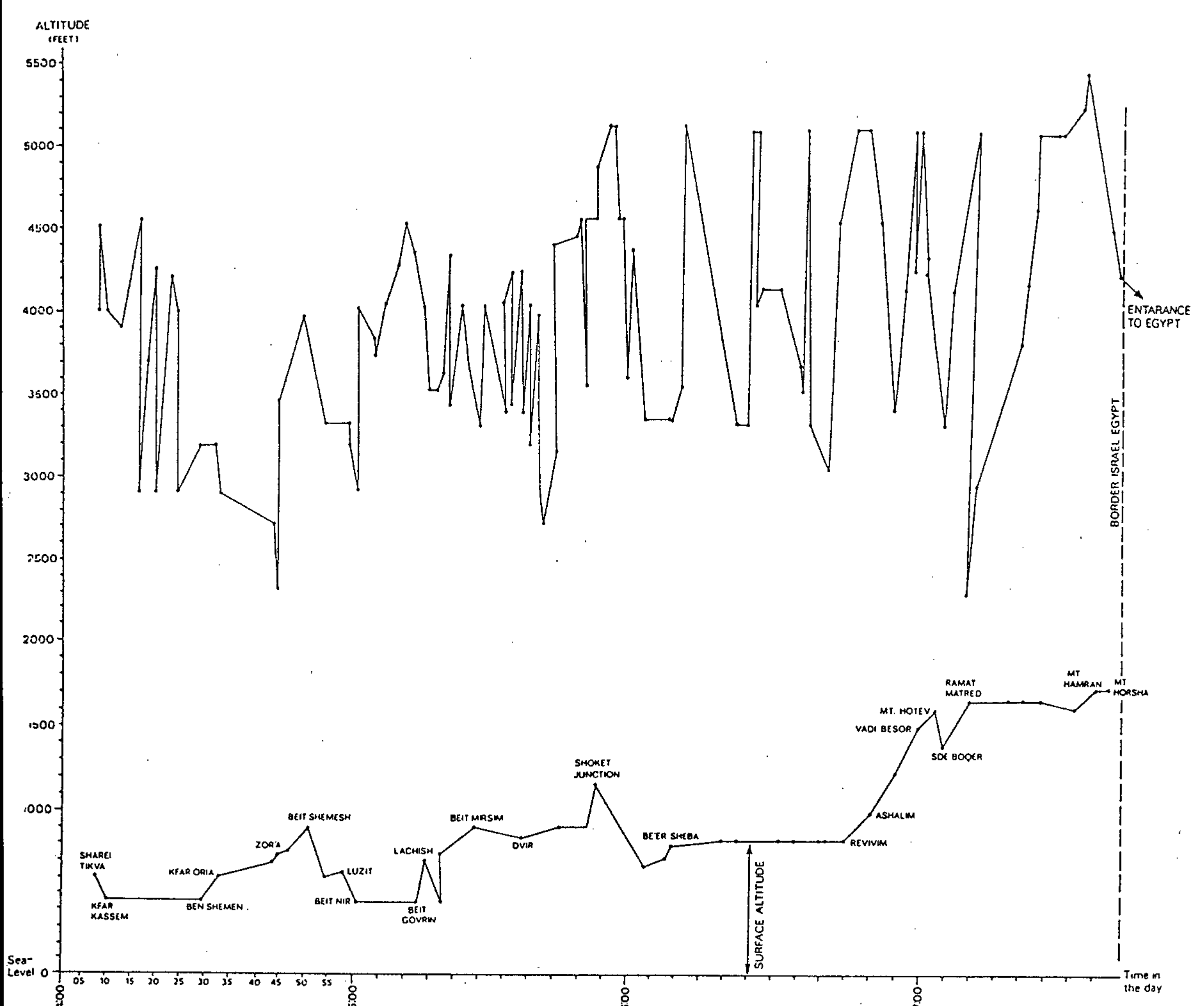
Photo 2

Above: The OGAR motorized research glider, made in Poland
Below: One of several posters produced by the IAF in cooperation with IRIC, to further pilots' awareness to the problem.



Graph 2.- A typical section representing raptor migration (Honey Buzzards, Pernis apivorus) as it was made with the motorized glider in autumn 1986 (5 September). The flight started at Sha'are Tiqva (22 km east of the Mediterraneam coast from Tel-Aviv) and ended at Mt. Hursha at the Egyptian border, a total of 186 km. At the Bottom of the graph is the altitude above ground along the way, and the flight altitude of the raptors soaring with one thermal and gliding on to the next one.

Wind: azimuth 300º, velocity -20-25 knots, clouds -4/8, altitude of cloud base -5500 feet.



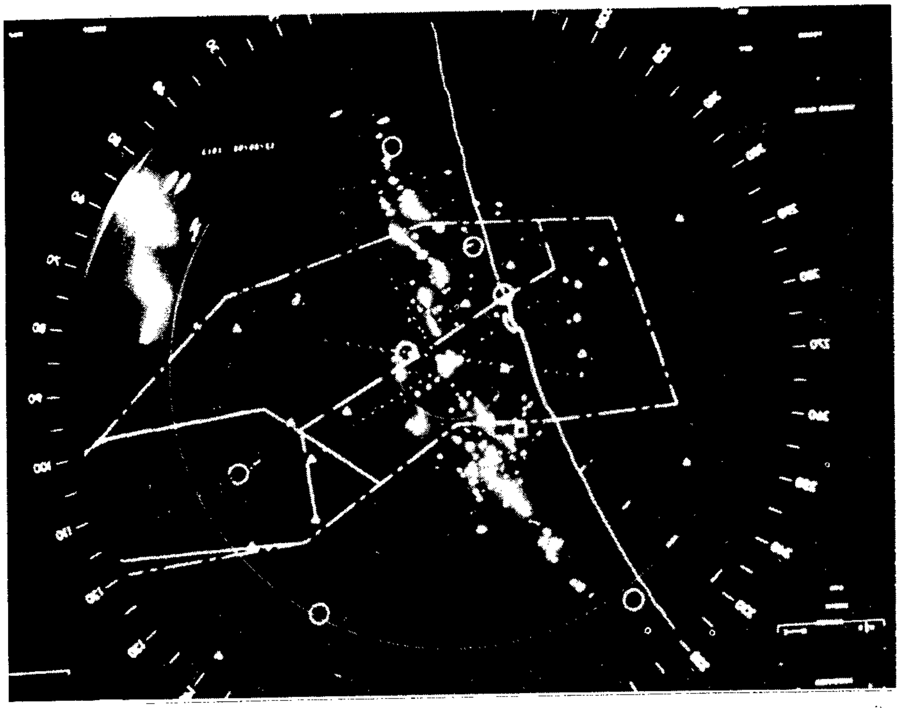


Photo 3 28.9.1986 (11:30) - Ben Gurion Airport radar (ASR-8) shows huge flocks (+/- 15,000) of Lesser-spotted Eagles (Aquila pomarina). Line is 82 km long (narrow line extending from due north to southwest in Mediterranean coastline).

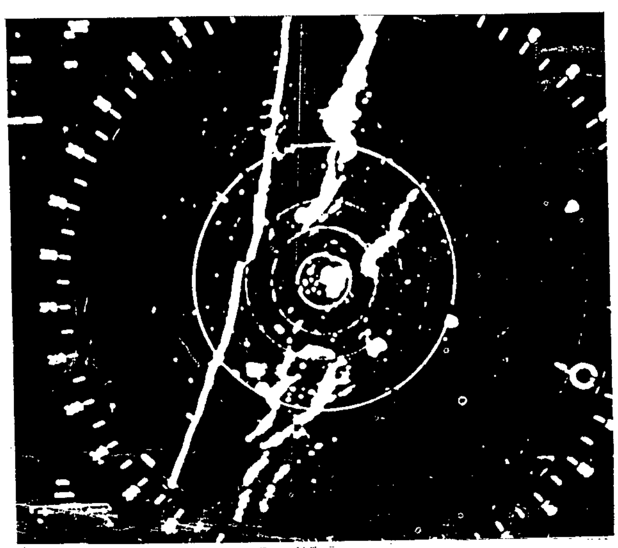


Photo 4 Hugh flocks of Honey Bazzards (Peenis apivorus) 11.9.86, 10 47 Ben Gurion Radar Lenghth of Lines 75 km. between 30,000 - 40,000 raptors, counted frech glider

Photo 5, above: 29/9/86, 9:30, satellite photo showing the barometric depression over Russia, Italy, Greece and Northern Turkey approaching our area - In Israel Lesser Spotted Eagle migrar1on is at a peak.

COMPARISON OF TWO SATELLITE PHOTOS:

Photo 6, below: 2/10/86, 12:30, the barometric depression is over our area - migration 'as stopped almost completely.

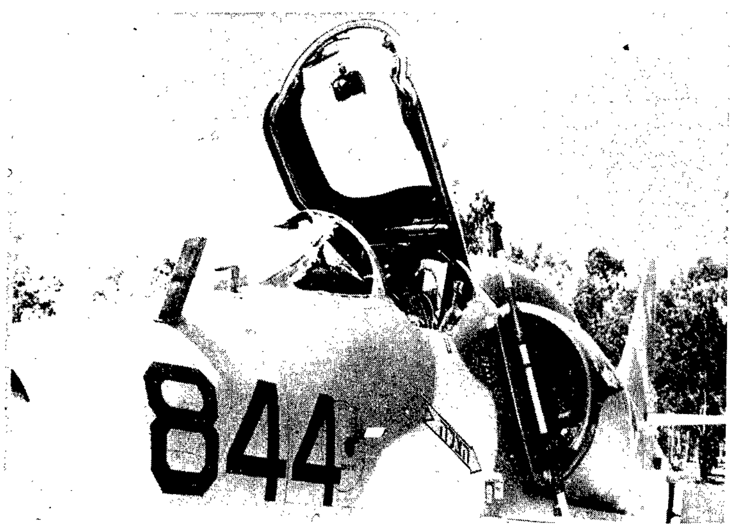


Photo 7, above: An Israeli Air Force Skyhawk with broken windshield - caused by white stork on spring migration.

Photo 8, below: The pilot of an IAF Skyhawk after the air collision

ADF616011

Recognizing bird targets on next generation weather radar

(Ronald P. Larking and Douglas B. Quine, EE.UU.)

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RECOGNIZING BIRD TARGETS ON NEXT GENERATION WEATHER RADAR

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Summary

By 1994, the present weather radars within the United States and at some overseas sites will have been replaced with a network of advanced Doppler radars, the Next Generation Weather Radar (NEXRAD). This paper discusses the final specifications of NEXRAD with respect to its performance in detecting and recognizing bird targets hazardous to aircraft. Techniques are outlined for automatically discriminating bird echoes from echoes caused by weather and for testing the performance of the automatic discrimination.

I. Introduction

A network of large Doppler weather radars is being built to cover the United States and some overseas locations. Because it will completely replace weather radars from the 1950s, it is termed Next Generation Weather Radar (NEXRAD). Although designed to detect weather phenomena, NEXRAD inevitably detects many bird targets as well. In this paper we discuss the characteristics of these large weather radars, their potential to detect various kinds of bird targets, and the status of efforts at the Illinois Natural History Survey (INHS) to implement recognition of bird targets in computer software.

Background information on the general characteristics of NEXRAD and illustrations of the appearance of migratory bird movements on NEXRAD are given in the proceedings of the 18th Bird Strike Committee Europe (DeFusco, et al., 1986).

II. Schedule of NEXRAD installation

A vendor has been selected for the NEXRAD system and final validation testing has just begun:

1988	Installation and final testing of first NEXRAD prototype unit
1990-1991	Installation of units 2-11
1992-1994	Installation of units 12-135, with more units available optionally

III. Characteristics of NEXRAD pertaining to bird targets

Most of NEXRAD's specifications are typical for a large weather radar (Joint Systems Project Office, 1984). The 10-cm wavelength of the radar penetrates cloud or haze yet backscatters strongly off bird targets. This wavelength, however, causes quantitative errors in estimation of the size of bird targets because 10 cm is similar in size to some birds and to body parts of birds.

NEXRAD has ample power and sensitivity for detecting birds at great range (DeFusco, et al., 1986). Birds (and insects) generate strong echoes whenever they fly in view of the radar and are not obscured by nearby ground targets. In some cases, however, NEXRAD electronics will suppress the echoes, as described below. Doppler velocity information on NEXRAD will be available to a range of 230 km, the maximum range over which we expect to be able to analyze bird echoes, although information on echo strength will be available out to 460 km.

NEXRAD projects a narrow 1-degree "pencil beam" that localizes targets in height as well as geographically. However the radar is designed for weather targets and does not permit fine resolution of targets close together in space. For this reason, NEXRAD can follow movements of large numbers or flocks of birds but cannot paint the fine structure of such flocks nor follow small flocks or individual birds. In measuring target velocity, NEXRAD allows 250-m resolution in range over its entire 230-km region of coverage for birds. For measurement of echo strength, the resolution widens to 1 km. As shown in Figure 1, NEXRAD paints with a broad brush (at 60 km the beam is 1 km wide).

NEXRAD radars will be located to provide good coverage for weather targets. In most cases, these sites will also provide good coverage for birds, unless the birds are (1) obscured by large ground targets, (2) so low and distant as to be obscured by the curvature of the earth, or (3) above the radar at elevation angles over about 15 degrees. Ground targets can often obscure such low-flying bird hazards as gulls and blackbirds (Figure 2).

To decrease the possibility that ground clutter would be mistaken for weather echoes, NEXRAD includes two types of clutter-rejection. In some cases, the clutter-rejection also rejects bird targets. In the first, a two-dimensional map of ground clutter is maintained continuously. Stationary targets at low altitude over this map are rejected by a mechanism similar to the circuitry of a classical Moving Target Indicator (MTI). (Stationary targets outside or distinctly above ground clutter are not rejected.) In the second type of clutter rejection, dot-echoes are rejected by a rather complex scheme that searches for single 250-m resolution cells that are much stronger than neighboring cells. Such cells are replaced by their weaker neighbors. In this manner, such isolated targets as aircraft, broadcast towers, single birds, or flocks much under 250 m in size are filtered out of the NEXRAD data. The dot-echo filtering can be switched off but present methods of measuring weather phenomena malfunction when dot-echoes remain in the data.

Targets intermediate between discrete dot-echoes and diffuse or spatially extended bird movements include important hazards to aircraft: birds or bats entering or departing roosts, coasting movements of gulls, large flocks of waterfowl, and sometimes migrating raptors. Figures 3 and 4 illustrate the effect of dot-echo filtering on one such kind of intermediate target, namely flocks of Canada Geese. The dot-echo filtering obviously reduces clutter. However many of the smaller flocks are also filtered out of the image or flicker on and off with successive sweeps of the radar. Larger flocks (Figure 5) prove steady, prominent NEXRAD targets.

Although NEXRAD is computer-controlled and can be programmed to move its antenna in arbitrarily complex patterns, its scanning strategies will be simple, at least during its first years. As NEXRAD searches for bird targets, the antenna will usually move in

360-degree sweeps in azimuth at increments of one degree in elevation. The maximum elevation will be about 15 degrees.

Both operational and research radars in use today rely on linearly polarized beams. Weather radars normally employ horizontal polarization; tracking radars often employ vertical polarization. In contrast, NEXRAD has a circularly polarized beam. Because circular polarization reflects poorly off flat surfaces, we expect echoes from ground targets, aircraft fuselages, and other surfaces to be attenuated on NEXRAD relative to echoes from cloud droplets, precipitation, and other weather targets. Bird targets are complex in shape and intermediate in size between ground targets and water drops. Bird targets can be expected to suffer some diminution of echo return because of the circular polarization; however, the degree of the effect of diminution of the echo remains open to speculation, as does the sensitivity of this effect to body size, target aspect, and the distribution of bird targets in space. We know of no radar studies of birds in which circular polarization was used. Based on primitive theoretical considerations, we expect that a few dB of echo loss will be incurred because of NEXRAD's circular polarization. Such loss would be a minor factor.

In addition to echo strength and radial velocity of targets, NEXRAD estimates the width of the Doppler spectrum. This estimate should provide an indication of how much the speed of the target varies during the time the 1-degree radar beam scans across the target. Ideally, this spectrum estimate approaches quantitative measurement of the second moment of a sample of the target velocity. The electronic methods used to estimate spectral width in Doppler radars are still in the development stage and presently produce imperfect but useful estimates of variability. We expect spectral width to be greater on average for bird targets than for weather targets. The INHS and the Illinois State Water Survey have been cooperating in studies of spectral width.

IV. Techniques for discriminating birds from other NEXRAD targets

The INHS is developing an algorithm[1] for discriminating birds from other targets such as weather and insects (Mueller and Larkin, 1985). The algorithm will be incorporated into the NEXRAD system after it is completed and is shown to be reliable. Discrimination of target types by the Bird Hazard Algorithm cannot be accomplished using one simple criterion but rather must use a combination of

[1]An algorithm is a precise procedure for carrying out a task. In this case, the task is recognizing bird targets on NEXRAD and algorithms are coded in a special language called NEXRAD Algorithm Enunciation Language (Joint Systems Project Office 1984, see also Appendix). In fact, the Bird Hazard Algorithm will be implemented as a small number of separate NEXRAD algorithms.

salient echo characteristics. We have identified several salient characteristics, which we call diagnostic variables. Because data on the actual appearance of birds on NEXRAD radars will not be available until about 1989, we rely on data from other similar radars in studies of possible diagnostic variables. The radars, data from which appear in our earlier BSCE contribution (DeFusco, et al. 1986), are Doppler weather radars designed for research. They closely resemble the NEXRAD specifications with the significant exception of linear rather than circular polarization.

The diagnostic variables presently number eleven (Table 1; see also Larkin and Quine, 1987). For some of them (e.g. Date) we can rely on information from published studies of bird movements as well as from long-term data sets available at the INHS and elsewhere. For others (e.g. Spectral Width), considerable basic research must be carried out before we shall have sufficient understanding to use the variable.

Verification of the actual kinds of airborne targets that produce a given region of echo on a large radar is especially important in developing a Bird Hazard Algorithm. We need to be certain which of several kinds of bird and weather targets produce the echoes. Among bird targets, the degree of hazard to aviation depends upon the kind and number of birds present in the air. Whenever possible, therefore, we have deployed ground observers with binoculars to identify and count birds while the radar operates (Figure 5). At night and when birds fly at high altitudes, we have used an INHS transportable tracking radar dedicated to detailed counting and, when possible, identification, of biological targets (Figure 6). With the tracker, we can identify broad classes of targets via wingbeat signatures and using telescopes and a radar-mounted spotlight.

The Bird Hazard Algorithm attempts to distinguish among five classes of radar echoes: weather, insects, migratory movements of mixed species of birds, migratory movements of waterfowl, and local movements of waterfowl. Other target types (for example, blackbirds and gulls) will be added when we have enough data. At least some of the five classes of echoes differ from one another on each of the diagnostic variables. Although a particular diagnostic variable may provide little or no help in making a decision about one class of echo, it may be helpful for another class. For instance, one finds time of day of no help in deciding whether a region of echo is generated by weather but most helpful in deciding whether the echo is generated by migratory passerines.

The computations that automatically distinguish among the classes of echoes rely on a matrix of probability functions, one function for each class of echo for each diagnostic variable. Figure 7 illustrates the data that support the probability functions. An example of a probability function appears in Figure 8. When a diagnostic variable is not helpful for a class of echo, that function equals 1.0. For each echo region, the computer evaluates the matrix of functions and for each class of echo it calculates

the joint probability across the diagnostic variables. If the computation succeeds, at least one joint probability will be nonzero and that of the correct class of echo will be larger than the others, thereby identifying the echo.

Although the calculation of 11 statistics on an echo region and subsequent evaluation of 55 to 75 functions seem laborious, the NEXRAD computer will not complain. To illustrate, we can process a an echo region of about 25,000 cells in under 10 seconds, on a minicomputer slower than the one NEXRAD uses.

V. Method of testing the Bird Hazard Algorithm

Because bird targets are in some ways poorly known on 10-cm weather radars and because of the complexity of the algorithm, we subject actual bird echoes to a working computer-coded algorithm. The researcher outlines regions of echo from known targets on a color Plan Position Indicator (PPI) image, using an interactive graphic display (Figure 9). After a region of interest is selected in this way, the computer stores _a priori_ target identification with the description of the region. Computation of the diagnostic variables then proceeds automatically and the resulting joint probability scores are compared with the _a priori_ identification to evaluate the success of the Bird Hazard Algorithm in categorizing the target.

Further work with these algorithms will consist of collecting data to construct and refine probability distributions, extending the algorithm to other classes of bird hazards such as blackbirds and gulls, devising methods to find interesting regions of echo and delineate them automatically for submission to the algorithm, and describing such site-specific diagnostic variables as geographic features and migration timetables.

VI. Acknowledgements

Data were gathered for this research at the U.S. Air Force Geophysics Laboratory, Illinois State Water Survey, Massachusetts Institute of Technology, and National Center for Atmospheric Research. Information on the NEXRAD radar system was provided by the NEXRAD Joint System Project Office. David Brunkow, Eugene Mueller, and Donald Staggs of the Illinois State Water Survey gave indispensible advice and technical help.

The U.S. Air Force and the U.S. Fish and Wildlife Service funded the research. We particularly appreciate the knowledgeable assistance and encouragement of Captain Russell DeFusco.

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Joint Systems Project Office for NEXRAD, 1984. NEXRAD Technical Requirements (NTR). Document R400A-SP-203 (reprinted, May 1985).

Larkin, R.P. and Quine, D.B. 1987. Report on bird movement data. Contract DACA-86-D-001 to the University of Illinois by the U.S. Army Construction Engineering Research Laboratory.

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TABLE 1. Diagnostic variables presently in use.

Coverage	Per cent of the echo region filled by targets
Date	Date of the data
Habitat	Codes for large habitat regions: oceans, wetlands, deserts, etc.
Height AGL	Distance from the ground, km
Reflectivity	Echo strength in decibels relative to a standard amount of water suspended evenly in air
Spectral width	Width of the Doppler spectrum, m/s
Stipple in reflectivity	In dB/km, see below
Stipple in velocity	In 1/ms, see below
Stipple in width	In 1/ms, see below
Time of day	Time relative to sunrise and sunset
Velocity	Radial speed, m/s

Note on stipple variables: Cloud, snow, and rain are composed of many tiny scatterers distributed rather evenly throughout the pulse volume of the radar and usually varying only moderately between adjacent pulse volumes. Bird echoes and sometimes insect echoes, on the other hand, are composed of fewer larger scatterers, so that variability occurs from one pulse volume to the next. Stipple measures the "roughness" of the echo region by taking the average of the first derivative of the relevant unit along radial samples of the echo region.

FIGURE 1. Size of a NEXRAD pulse volume.

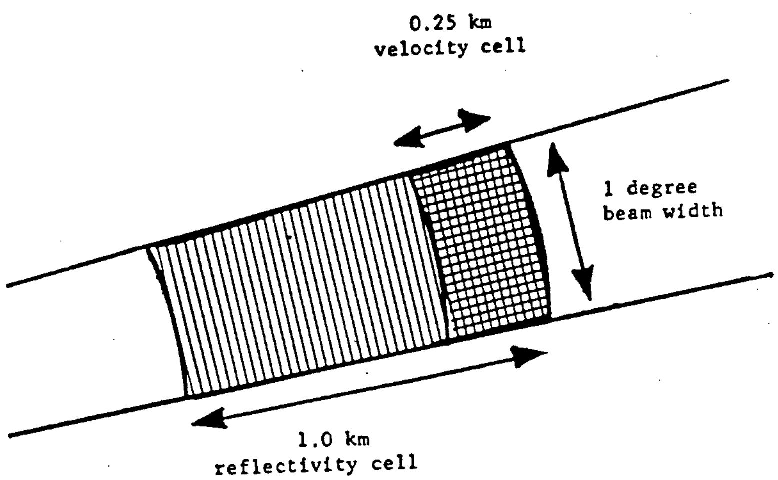


FIGURE 2. Low-height coverage of the NEXRAD beam.

(Note that X and Y axis scales differ.)

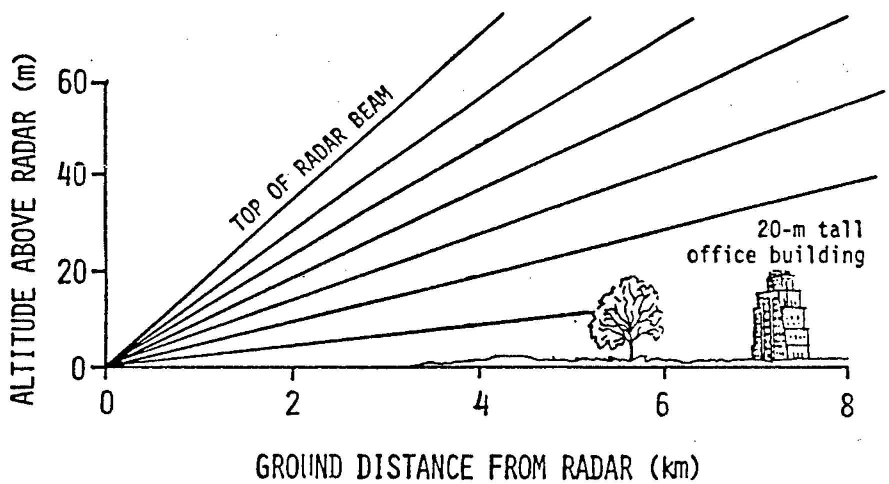


FIGURE 3. PPI of goose flocks from research radar.

The data were taken on 16 December 1987 with the CHILL radar of the Illinois State Water Survey using a gate spacing of 150 m for both echo strength and velocity. Dot-echoes have not been suppressed. Compare with Figure 4.

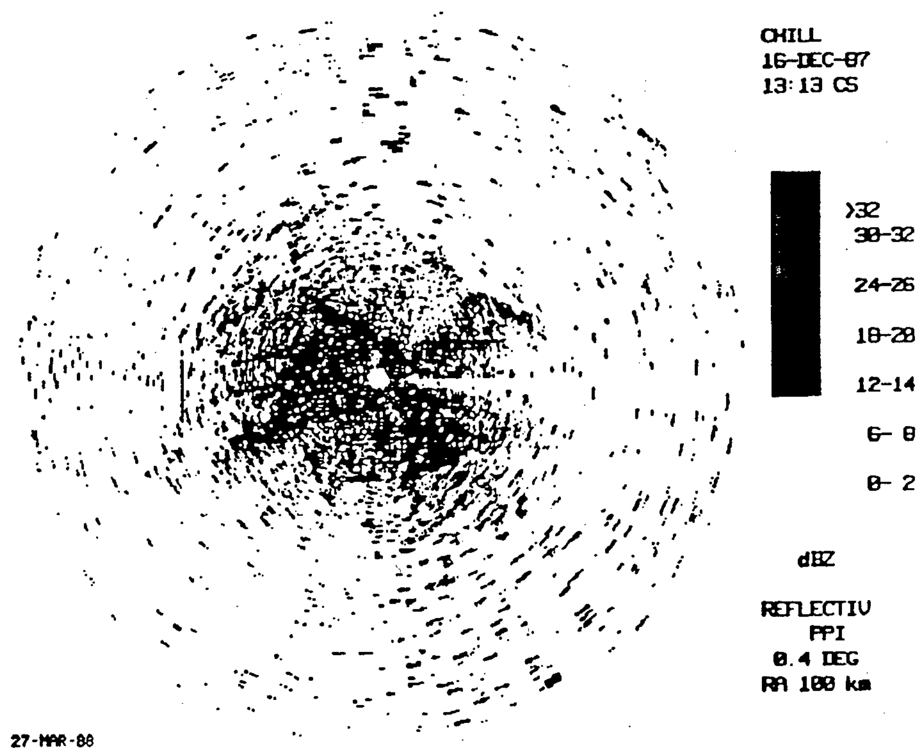


FIGURE 4. PPI of goose flocks as seen on NEXRAD.

The data of Figure 3 were processed to produce a close approximation of NEXRAD's gate spacings of 250 m in velocity and NEXRAD's dot-echo suppression.

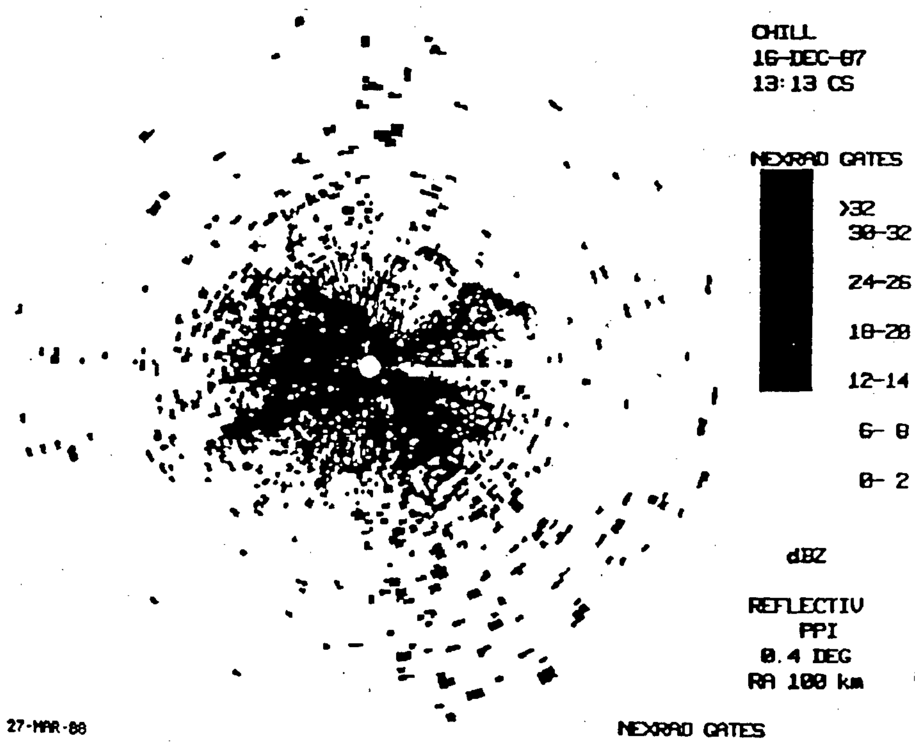


FIGURE 5. Spatial spans of flocks of Canada Geese.

Data were taken by observers with binoculars counting geese (N about 20,000) at Champaign, Illinois. The geese were migrating from Horicon, Wisconsin to southern parts of Illinois and neighboring areas. Spans assume geese flew with their bodies spaced at 3-m intervals.

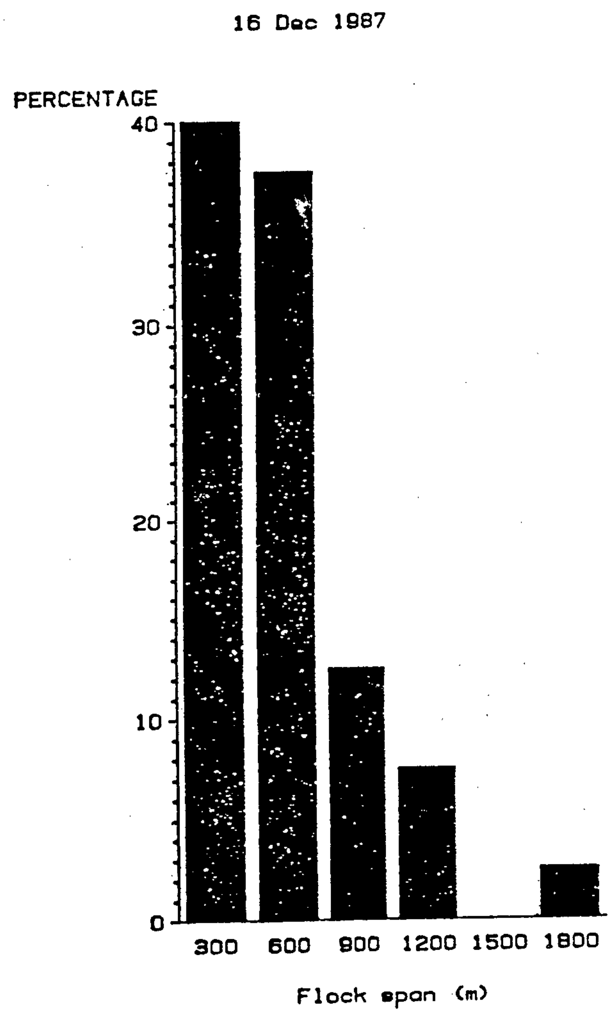


FIGURE 6. Illinois Natural History Survey 3-cm tracking radar.

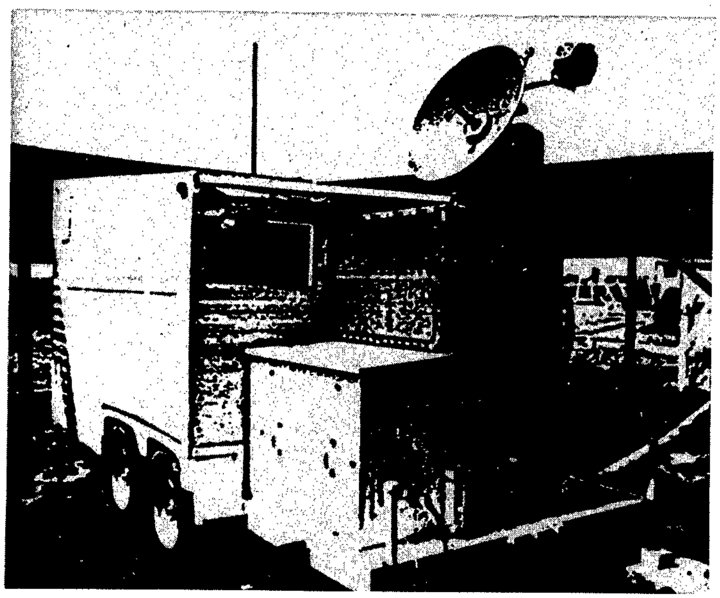


FIGURE 7. Stipple in reflectivity by target composition.

A measure of small-scale spatial variation in amount of returned radar echo for both homogeneous and composite targets. Note that a region of echo that has a score on this diagnostic variable of more than about 3 should be due to a biological target rather than to weather.

	Stipple in Reflectivity, dBZ								
	0	1	2	3	4	5	6	8	12
	N	N	N	N	N	N	N	N	N
Target composition									
All types below	.	.	1	.	.	.	.	.	.
Passerine	.	7	.	2	5	1	.	1	.
Passerine + Weather	.	.	.	.	1	.	.	.	.
Waterfowl	.	.	.	.	2	2	1	.	.
Waterfowl + Passerines	.	2	1	1	3	.	1	.	1
Waterfowl + Weather	.	.	.	.	1	.	.	.	.
Weather	1	8	17	3	.	.	.	.	.

FIGURE 8. Probability distribution for the Date variable for the case of passerine migrants.

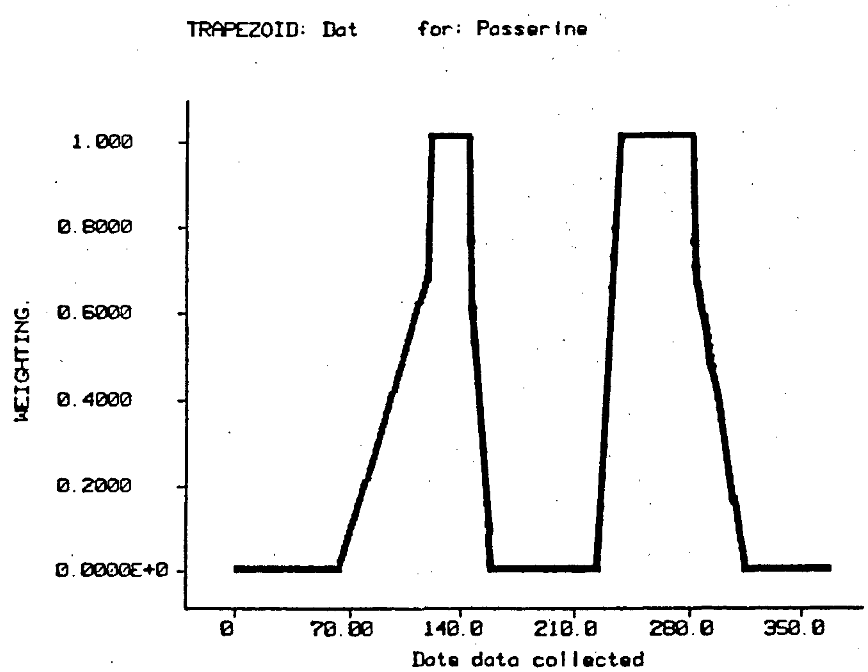
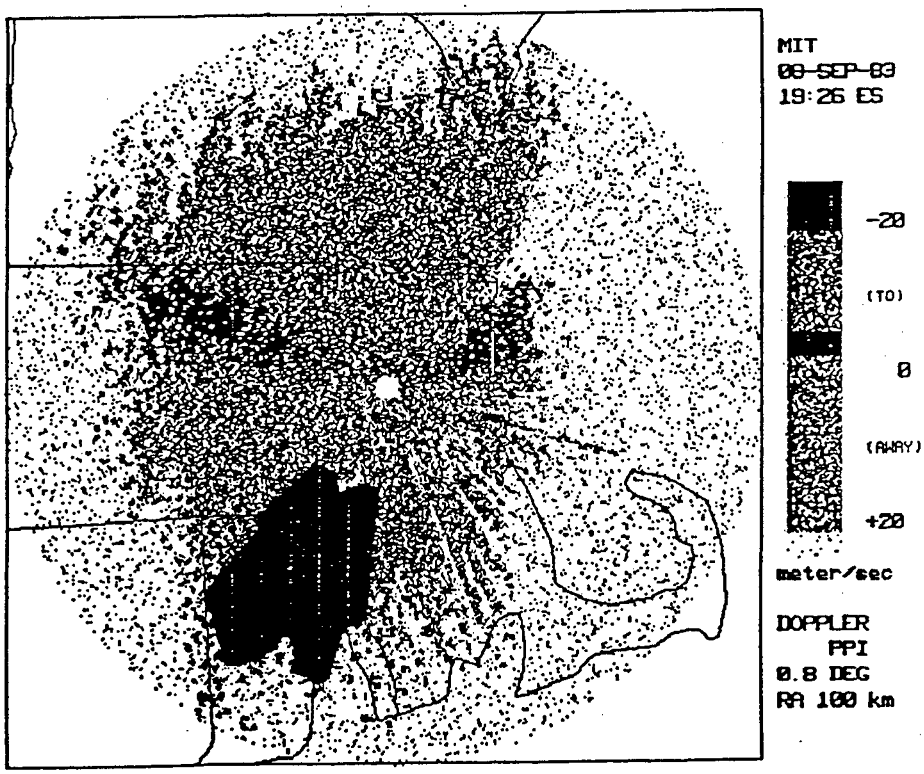


FIGURE 9. Graphical designation of a region of echo for analysis and submission to the Bird Hazard Algorithm.

The image is a monochrome rendition of a color PPI of velocity over the northeastern United States. The radar is located at the Massachusetts Institute of Technology in Cambridge, Massachusetts, at the center of the display. The rectangle is 200 km across. The irregular-shaped area of echo extending out to 40-90 km range is due to migrating birds on a night of normal fall migration. The echo is mostly passerines, but may include some insect echo as well. Echoes to the E and SE are due to tall buildings that reflect and obstruct the radar beam. A dark area to the SSW over the state of Rhode Island has been drawn by the operator to designate a region of receding birds for analysis by the Bird Hazard Algorithm.



S10_TO_P300 DATE: 28-MAR-88 GRAYSCALE: GRAY49.BW

APPENDIX. Example of Algorithm Enunciation Language

This fragmentary example illustrates the NEXRAD A.E.L. In the full algorithm, the terms are carefully defined prior to being used. The fragment checks to see if an echo region is undoubtedly weather; if so, the geographic area is marked to avoid a probably fruitless search for numbers of birds flying beneath what is likely to be rainclouds.

```
DO FOR ALL (ECHO SEGMENTS)
    IF (ECHO SEGMENT has elements >
                        THRESHOLD(Maximum Bird Height)) OR
         (MEAN REFLECTIVITY(Echo Segment) >
                      THRESHOLD (Bird Reflectivity)) OR
            (At least 1 POSITION (Gage Reports) is beneath this
            ECHO SEGMENT AND NOT (FLAG (No Hourly
            Accumulation) for said position)
        THEN
            Set WEATHER MAP elements beneath echo segment
    END IF
END DO
```

ADF616012

Fundamental Experiences and Suggestions for Biotope-Management-Procedures on International Airports

(Dr. Jochen Hild, Germany)

BSCE 19/WP 15
Madrid, 23-28 May 1988

FUNDAMENTAL EXPERIENCES AND SUGGESTIONS FOR BIOTOPE-MANAGEMENT-PROCEDURES ON INTERNATIONAL AIRPORTS

By Dr.Jochen Hild, Chairman Birdstrike Committee Germany
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Summary:In order to minimize birdstrike-risk Lufthansa German Airlines started a special ecological advisory program especially for airports in Asia, Africa, Middle and South-America serviced by DLH. This report deals with the experiences gained in countries with different climatic conditions which result in different types of birdstrike problems. Before this could be done it was necessary to study the special ecological situation in these areas, for only on the basis on such ecological investigation and consideration will it be possible to solve local bird hazard problems.

1. INTRODUCTION.

Every year Lufthansa German Airlines records more than 300 birdstrikes worldwide. Since each incident potentially causes a high amount of damage, not only German airports with their specially developed ecologically-based biotope programs for bird scaring, but also many airports, especially in the Far East and Africa, have been visited during the last 10 years to discuss birdstrike problems with airport authorities, institutes and regional biologists.

This report deals with the experiences gained in countries with different climatic conditions which result in different types of birdstrike problems. Before this could be done it was necessary to study the special ecological siutiation in these areas, for only on the basis of such ecological investigation and considerations will it be possible to solve local bird hazard problems.

2. BASIC INVESTIGATION PROGRAMS.

In various official and inofficial manuals (e.g.ICAO DOC 9137, Part 3) and regulation a large list of provisions for scaring birds on airports has been published; the impression may arise hat, in following these recommendations or orders, all things have been done and all problems could be solved. Therefore it is very important to state, that it is a basic requirement for all measures on airports to have basic ecological research available if provisions are to be successful; the airports of Copenhagen and Manchester may be an example. This ecological research should be based on several years of investigations of all biotic and abiotic parameters and these investigations should be repeated every 4 or 5 years because the ecological situation on airports changes since ecological systems are dynamical and special ecological provisions for bird-scaring may change the situation. Moreover, it must be stated that <u>all</u> direct provisions against birds will always be effective only for a short time, and that the most effective and lasting method will be the biotope management which can only be based on ecological background reserach.

It is a fundamental biological rule, that it is impossible to create a vacuum in nature, therefore the ecosystem airport will always have a special avifauna depending on the special ecological situation on the airport itself, but this situation generally can be changed by a special biotope management, so that further development of the avifauna can be influenced for the benefit of flight safety. Some examples ! For the Frankfurt Airport a program for changing grassland to long grass usage has been developed which will solve the problems with crows, lapwings, starlings and birds of prey. In Hongkong Airport a sewage program related to the sea coast were under discussion and solved the problems with gulls; in Hamburg Airport a special scientific investigation has been carried out because of the problems with gulls and lapwings, and in Singapore and Jakarta-Cengkareng the ecological development of the airport areas is still in fluctuation, so that final recommendations are impossible to give, but ecological background research must now be carried out to influence these developments into a positive direction for flight safety. At Manila International and Kuala Lumpur-Subang as well as in the airports of Bombay, New Delhi and Bangkok relationsships between grassland usage, monthly precipitation, temporary inundations, water capacity of the soils and birds appearance are of high relevance and require more years research before deciding on special procedures.
An airport is always a dynamic ecosystem which can be manipulated, so that e.g. large birds are scared, and at the same time small birds are attracted. It is

very important not to take measures against birds by inflexible programs which are to be valid for all airports of the region, but to develop flexible programs regarding the special local biological and ecological situation.

The basic investigation on each airport and in its vicinity should consist of:

- Statistical evaluation of birdstrikes and determination of bird remains after strikes coming from planes or runways. This requires a complete reporting system and exchange of birdstrike reports between air transport companies of all countries which make use of the airport in order to get information about the real degree of danger, the species of birds involved, their quantities depending on season and weather as well as their behaviour.
- Analysis of ecological facts, such as:
    * Climatology for judgement of drainage necessities, inundations, growth of grassland and its mowing, as well as appearance of birds during short-scale, mesoscale, and long-distance migration. The types of migration can not be generalized, because the basic situation influencing the bird migration is different in each country of the world.
    * Phenology of plants for judgement of seasonal food-supply for birds.
    * Hydrology and soils for judgement of the ground-water regime and soil water capacity which is important for plant growth, and drainage provisions.
    * Vegetation for judgement of food supply, breeding possibilities, and mowing methods, for plantations of shrubs and trees.
    * Birds, residents and visitors in their seasonal fluctuations and local dependencies on other biotic and abiotic parameters.
    * Other vertebrate and invertebrate animals in and on the soil/ground for judgement of food supply.

Only after such basic investigations directed provisions of biotope management or direct provisions, e.g.electroacoustical/pyroacoustical measures, should be concluded.

3. SPECIAL INVESTIGATION PROGRAMS.

The visit and ecological ratings on many airports showed some special problems which depend on the special climatological situation within the corresponding countries:

a) Grassland use on airports: in Middle Europe many years of ornithological investigation led to the result that for the existing avifauna on the airports long-grass-use with cutting twice a year with or without removal of grass-material is used more than short-grass-use which is higly attractive for gulls, plovers, crows, starlings, thrushes and sparrows. Furthermore during the last years long-grass-use has been introduced on most airports and airfields and showed the following advantages:

    * Reduction of birdstrike-risk by being less attractive for larger birds by supplying less food, being less attractive for birds of prey hunting small vertebrates because of a reduction in the offer of albumen. Possibly small insectivorious birds will be favoured because of the better development of flying insects in the long-grass-areas.

* Improvement of the ecological situation by development of more natural plant societies, soil protection and good ecological circulation.

* Economic improvement by less cuttings, economization of fertilizers and reduction of costs.

In the tropic and subtropic zones long-grass-use is not comparable with long-grass in Europe; rain periods - caused by the passat- and monsoon-wind-systems - influence the possibility of cultivation and the fluctuation e.g. of soil arthropodes as well as of flying insects. Therefore special investigation programs should be carried out for several years with the aim of determining the best grassland cultivation methods with regard to the local composition of the avifauna. For one airport it may be recommendable to have long-grass-use without any cultivation for another occasional mowing might be better and for still another the short-grass-procedure should be applied.

The following investigations are proposed for the determination of the final grassland-use:

- Installation of test areas with long- and short-grass, observation of bird species and quantities, grass- and dicotyle-growth, soil vertebrates and invertebrates as well as flying insects by trapping, and observation of the physico-chemical situation of the soil under the existing cultivation conditions.
- Installation of test areas using growth inhibitors if permissible in order to reduce the number of yearly mowings.

b) Bird migration studies by radar and visual methods:

Outside Europe the migration situation is more complicated than within Europe where migratory birds are highly dependent on weather and phenological situation of the vegetation.

In all region of the world different migratory types exist. Therefore special observation programs could be helpful as a basis for the development of special warning/forecasting procedures for airport districts, too. Such programs should be based on radar and visual observations and could help to draw up probability analyses.

c) Bird migration and weather: the interaction between migrant birds and weather or meteorological parameters differs dependent on migration type. Transzonal migrations are controlled by weather and instinct; for the regional and local migrants - important for airport districts - only supply of food, position of roosting and feeding places, upcoming thunderstorms as well as tides are highly important.

Correlations between weather and bird movements are only possible by comparing corresponding data over many years and by developing computer programs.

4. FUTURE ACTIVITIES.

Ten years ago Lufthansa German Airlines developed a special advisory program which is made available free of costs especially to airports serviced by Lufthansa in Africa, Asia, Middle and South-America which are interested to utilize the more than 20 years of experience with the bird hazard problem. This program has been carried out together with biologists of die Birdstrike Committee Germany and refers to more than 30 airports in Europe, Asia, and Africa. It goes without saying that this type of advisory cannot and will not replace a detailled and dif-

ferentiated ecological analysis, but it can and will be a rating and a guideline for the countries which have a lack of experience. The development of birdstrikes encountered by Lufthansa German Airlines especially in some regions of Africa and Asia shows that flight safety tendencies are improving, but these tendencies must be observed over longer periods in order to reach final judgements.

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ADF 616013

Birds at Copenhagen Airport

(A. M. Glennung, Kastrup)

BSCE 19/WP 16

Madrid, 23-28 May 1988

COPENHAGEN AIRPORTS AUTHORITY

Birds at Copenhagen Airport, Kastrup

Copenhagen Airport is situated on an island in an area very rich of birds. The seasonal migrations of the birds pass this area and important breeding-, feeding and resting areas surround the airport. In addition to that the area of the airport itself is very attractive to the many birds, as the greater part of the airport is covered with fertile top soil.

So a lot of birds have always been at the airport but here as well as in other places the problem was not considered until the start of jet planes in civil traffic.

The first preventive effort was made by sending a man out in the airport area in order to scare away the birds by using a sporting gun and pyrotechnics. This resulted in the establishment of a specially trained patrol equipped with both sporting gun, pyrotechnics and birds distress call. The members of the patrol are trained to be hunters and are picked among the best qualified of the airport guards, as a wide knowledge of the infrastructure of the airport is essential.

To reduce the number of herring gulls in the airport area a combat was started in 1969 against the herring gulls on the island Saltholm 4 km east of the airport by spraying their eggs with oil emulsion. This form of combat has continued every year since then. But in order to accellerate the combat in 1976 also alfa chloralose was used. When the population of herring gulls on Saltholm culminated it was estimated to 44.000 pairs. The goal was to reduce the

population to 5.000 pairs.

It was a great help when a large dumping ground for domestic garbage situated 5 km NV of the airport was closed down in 1972.

In 1986 and 1987 the above goal was reached. Since only about 5,000 nests were found, the fact of which was found to be the lower limit for an intensive combat.

What effect has the combat of herring gulls on Saltholm had for the risk of bird strike at the airport ?

By counting the number of breeding herring gulls during the combat on Saltholm and counting both the number of birds and the time they were observed at the airport - during which they cause a risk of strikes, some correlation can be found. - All set of numbers decreased during the years 1976 - 1981.

But the number of breeding herring gulls show a steady decrease since the beginning of the combat and up to now, whereas the number of birds in the airport and the time they are observed start to increase from 1982. A closer investigation shows that now the birds at the airport are not mainly herring gulls as they were previously but other species of birds especially black-headed and common gulls are seen in increasing numbers.

For many years the herring gulls have dominated the bird life both on Saltholm and at the airport, but as a consequence of the combat the other species of gulls have had an opportunity to get into the area around the airport and on Saltholm. The combat of the gulls on Saltholm has therefore to include the combat of black-headed and common gulls, if a reduction of the bird strike risk on the airport shall be achived.

The wish for a permission to combat these gulls has therefore resulted in an application to the wild life administration, but a permission for an extended combat has not yet been granted.

A.M. Glennung

A.M. Glennung

ADF616014

Radar and visual observations of sea duck's mass spring migrations in the west Estonia and the transmission of birdtam from Tallim airport to Helsinki-Vantaa Airport

(V.E. Yacoby, URSS)

BSCE 19/WP 17

Madrid, 23-28 May 1988

RADAR AND VISUAL OBSERVATIONS OF SEA DUCK'S MASS SPRING MIGRATIONS IN THE WEST ESTONIA AND THE TRANSMISSION OF BIRDTAM FROM TALLIN AIRPORT TO HELSINKI-VANTAA AIRPORT.

V.E.YACOBY, USSR

Summary

Radar and visual observation of the mass spring migration of three species see ducks show,that about 300 thousands this birds in period 15-30 May flies in West Estonia by the next ways; 1.Along West Estonian coast 2.Toward north-east,crossing the land only in tail wind and on big altitude. There are transmission BIRDTAM between airports Tallin and Helsinki-Vantaa.There are recommendation of International Conference Baltic Birds-5 to spread BIRDTAM and to include other countries and other bird species.

As the result of many years visual observations over the mass spring migration of mainly three species of sea ducks (Clangula hyemalis, Melanitta nigra, Melanitta fusca) at Muhuvain strait from the Puhtu ornithological station - it was ascertain that here up to 800 thousands sea ducks are migrating by waves each year toward the north and north-north-west along Western Estonia sea coast. Migration is taking place during 15-30 May between 19 o'clock and midnight. Migration proceeded at low altitude under head and head-side winds and at high altitude under tail wind. Simultaneous visual observations of migrations at Puhtu and at north-western extremity of Estonia (Pyezaspea cape) have shown that the numbers of migration in this last place is considerably lower than in the first place. This could happen as a result of sea ducks migration over a land but not alongside the sea coast. Radar observation have confirmed the migration of sea ducks over a land toward the north-east from the western to the northern seacoast of Estonia under south-western and western winds. The flight over a land has proceeded by comparatively wide front (20-30 km.). The climbing of altitude and the start of flight over land has been noted more often before the sunset. When flying out to sea after having crossed a land the altitude of flight is decreasing sharply and at 30 km distance from the seacoast sea ducks are coming out of the radar sight.

In such a way, by forecasting wind direction it is possible to predict the time, place, direction and altitude of the seaduck migration.

On the basis of radar and visual observation mentioned above, and according to recommendation of Moscow and Rome meetings of Bird Strike Committee Europe in 1986-1987 the notification, similar to storm one, was transmitted by coded telegrams (BIRDTAM) about seaduck migrations within 15-30 May period from airport Tallin to airport Helsinki-Vantaa. In the autumn the BIRDTAM was transmitted in reverse direction.

11-13.XI.1987 the soviet and finnish aviation experts and ornithologists discussed the course of these works execution. They admitted the desirability to continue them and to modernize the code of telegram transmission by increasing the number of bird species: in addition to mentioned above also Branta bernicla, Branta leucopsis, Anser albifrons, Grus grus and by changing some other details of Birdtam telegram. At present time we are trying to expand Birdtam by sending information to Finland about the start of mass autumn sea duck migration from the White Sea. The recommendation of the International Conference Baltic birds-5 (Riga, October 1987) provide for to expand BIRDTAM abot seaducks in the spring and in the autumn by including Poland, East and West Germany, Denmark and about geese and cranes migration to add Sweden to these countries.

This cooperation will help to disclose such regularities of bird migration which will make it possible to predict them more accurately and before longer time.

Bird Avoidance

(John Thorpe, UK)

BSCE 19/WP 18

Madrid, 23-28 May 1988

BIRD STRIKE COMMITTEE EUROPE

BIRD AVOIDANCE

John Thorpe - UK CAA

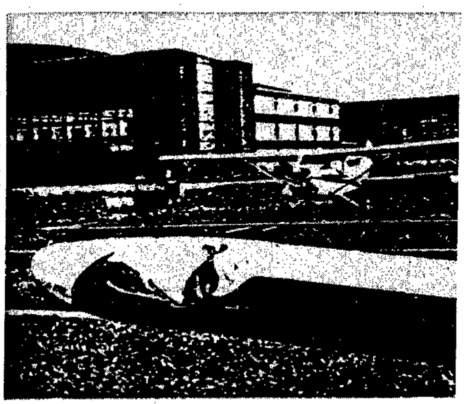
SUMMARY

The paper contains the text of a Leaflet in the CAA General Aviation Safety Sense series. This has been widely distributed to UK General Aviation and Private pilots. Other countries may wish to use the text for similar leaflets with suitable alteration to reflect their own reporting procedures, bird species, publications, etc.

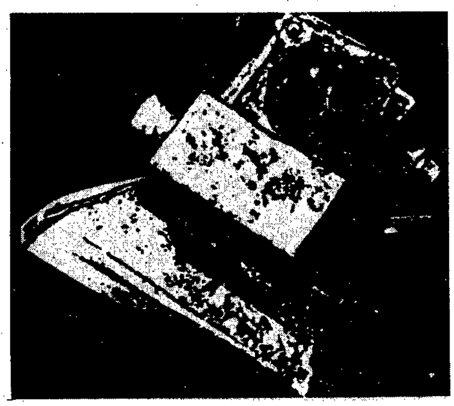
BIRD AVOIDANCE

1. Introduction

You may not realise it, but if you collide with a soft feathery bird the effect of speed may cause it to seem more like a missile capable of inflicting considerable damage. Although only 5% of bird strikes cause damage, improved pilot awareness of the problem may prevent bird strikes and to help correct handling of the situation if a strike occurs. About 95 incidents per year are reported by UK general aviation pilots and the effects include smashed windshields (injuring pilots), blocked engine air intakes, broken pitot heads, damaged brake hoses, holed structures and helicopter tail rotor damage. However, many pilots never experience a bird strike.



Damaged Piper Aztec wing after striking a Grey Heron (weight 1.5kg) at 105kts.



At 140 kts while practising for an Air Race round the Isle of Wight, the engine air intake was blocked by a Belgian pigeon. Aircraft force landed on the beach (the tide was out!).

The advice below should help to minimise bird strikes and their consequences.

2. Prior to Flight

a. Check aerodrome documentation and NOTAMS (issued by some countries as BIRDTAMS) for information about permanent or seasonal bird problems at both departure and destination aerodromes.

b. Plan to fly above 2,500 feet; the higher the better. Only 1% of UK general aviation bird strikes occur above this altitude.

c. Avoid flying over bird and wildlife sanctuaries detailed in aeronautical publications (UK Air Pilot Section RAC 5-1-4 para 6.6) or marked on aeronautical charts.

d. Plan to avoid flying along rivers or shore lines in the Autumn and Spring. Migrating birds, as well as pilots, may use these useful navigational features.

e. Bear in mind that birds do fly at night.

f. Discuss emergency procedures before departure, including those if the cockpit communications are lost.

g. The higher the speed, the less time birds have to get out of your way. Consider using goggles and helmet during air racing or other high-speed low-altitude operations.

h. In late summer the risk of a strike is at its greatest because young birds are unaware that aircraft are a hazard, while the flying qualities of adult birds are impaired as they moult their flight feathers.

i. Birds of Prey have been known to attack aircraft!

3. At the Aerodrome and In Flight

a. Inspect the aircraft thoroughly for birds nests, they can build one overnight!

b. As you taxi out, listen for any bird warnings on the ATIS e.g. a mass release of racing pigeons.

c. When taxying, watch for birds on the aerodrome. Note that the most frequently struck birds, gulls, have a grey or black back which is good camouflage on concrete or tarmac runways.

d. If you are flying a quiet aircraft remember that birds on the ground face into wind and may not hear or see you coming.

e. Note that the slower the bird's wingbeat, the bigger the bird and the more hazardous it is.

f. If birds are observed, request that aerodrome personnel disperse the birds before take-off. This is particularly important for turbo-prop and jet powered aircraft at aerodromes mainly used by smaller general aviation aircraft (the birds may have got used to slow aircraft). Never use an aircraft to scare birds away.

g. If the aircraft has windshield heating, remember that its use, in accordance with the Pilots Operating Handbook or Flight Manual, will make the windshield more pliable and better able to withstand bird impact. (See AIC 54/1983 (Pink 45) - Effect of Temperature on the Resistance of Glass Laminated Windscreens to Bird Impact)

h. Use landing lights during take-off, climb, descent, approach and landing. Although there is no conclusive evidence that birds see and avoid aircraft lights, lights will make the aircraft more visible.

i. If a bird strike occurs during the take-off run, stop if remaining runway will allow. Vacate the runway and shutdown. Inspect the intake, engine etc for damage or ingestion, or for bird remains blocking cooling or other airflow before attempting a second take-off. Several airline incidents have occurred where turbine engine damage or high vibration developed during subsequent flight because of undetected engine damage. Don't forget to check landing gear and brake hydraulic lines, downlocks, weight switches etc.

j. If the take-off must be continued, with an engine problem, properly identify the affected engine and execute emergency procedures and tell the aerodrome why you are returning.

k. If you see bird(s) ahead of you, attempt to get over the top, as birds most often break-away downwards. Be careful when near the ground, and **NEVER** do anything that will lead to a **STALL** or **SPIN**.

l. If structural or control system damage is suspected (or the windshield is holed) consider the need for a controllability check before attempting a landing. Be wary of unseen tail rotor damage on helicopters.

m. If the windshield is broken, (or cracked) slow the aircraft to reduce wind blast, follow approved procedures (depressurise on pressurised aircraft) use sunglasses or smoke goggles to reduce the effect of wind, precipitation, or debris, but remember to **fly the aircraft** - don't be too distracted by the blood, feathers, smell and windblast. Note that small general aviation aircraft and helicopter windshields are not tested against bird impact and the propeller gives little protection. However, most aircraft between 2,300 Kg and 5,700 Kg can withstand a 900gm (2 lb) bird. Gulls, pigeons, lapwings and even swifts can hole light aircraft windshields.

n. If dense bird concentrations are expected, avoid high-speed descent and approach. Halving the speed results in a quarter of the impact energy.

o. If flocks of birds are encountered during descent or approach, go-around, and climb before circling for a second approach. Birds can migrate in waves across a wide front, therefore a short delay in the approach could result in clear airspace.

4. After Flight

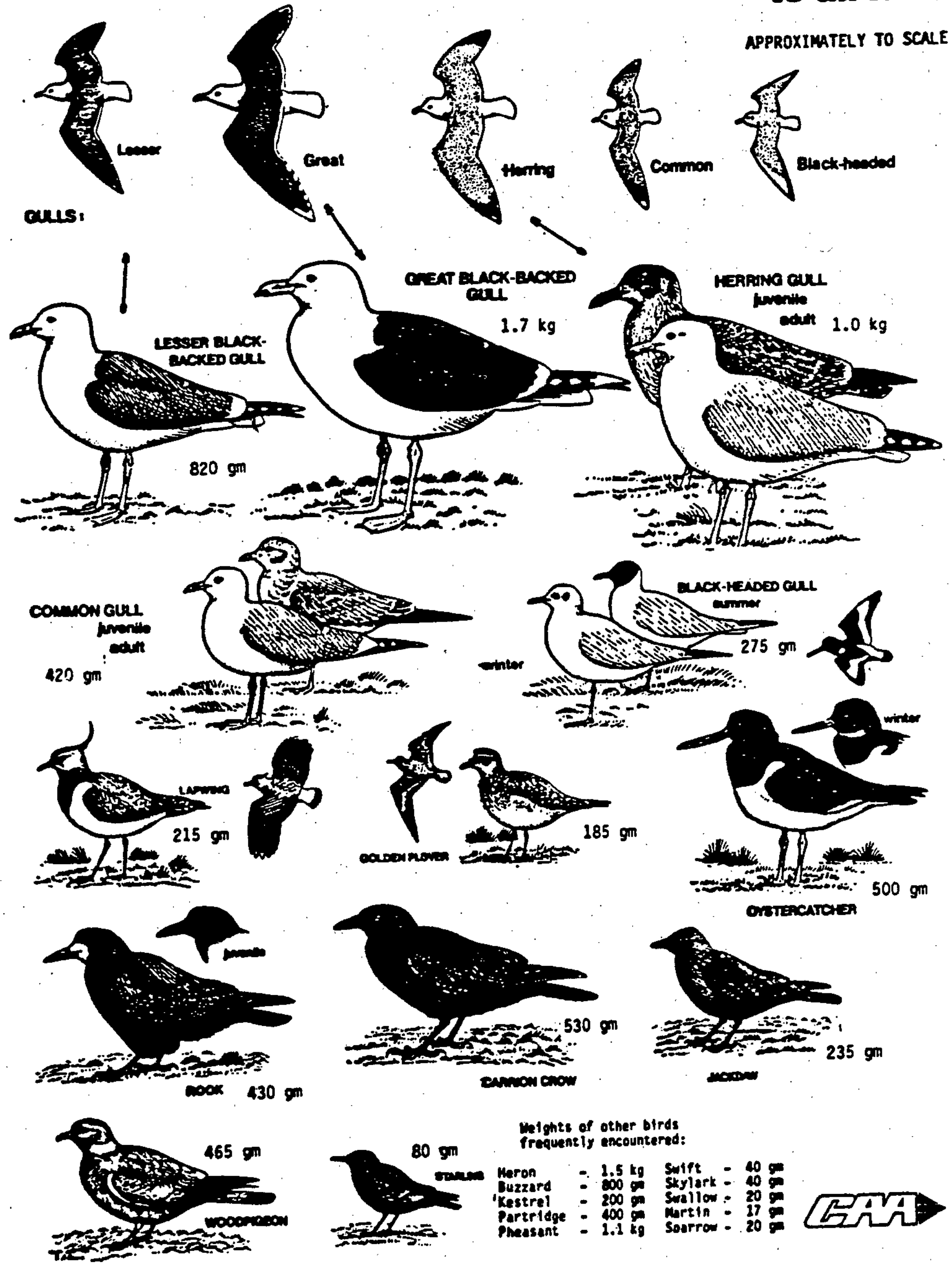
a. After landing, if you have had a bird strike check the aircraft for damage.

b. Report all bird strikes on the yellow National Bird Strike Report Form CA1282. This should be available at the Briefing Room/Control Tower/Flying Club (copy on the back of this leaflet).

c. If you are not sure of the species send the remains (even feathers can be sufficient) for identification to the address on the Report Form. (Aviation Bird Unit, Tangley Place, Worplesdon, Guildford, Surrey. GU3 3LQ).

d. Photograph any damage, and send to the Safety Data and Analysis Unit.

LOOK OUT FOR THESE BIRDS - they can be a hazard to aircraft



Civil Aviation Authority

BIRD STRIKE REPORTING FORM — CA 1282

To be completed for ALL strikes, including those where evidence is discovered by ground and overhaul personnel. Also to be used for strikes which qualify as Reportable Occurrences under Article 85 of the ANO – see Aeronautical Information Circular on Bird Strikes. (Numbers are for computer analysis.)

Operator 01/02

Aircraft Make/Model 03/04

Engine Make/Model 05/06

Aircraft Registration 07

Date day .... month .... year 08

Local Time 09

dawn ☐ A day ☐ B dusk ☐ C night ☐ D 10

Aerodrome Name 11/12

Runway Used 13

Location if En Route 14

Height (AGL) .... ft 15

Speed (IAS) .... kt 16

Phase of Flight 17

parked	☐	A	en route	☐	E
taxi	☐	B	descent	☐	F
take-off run	☐	C	approach	☐	G
climb	☐	D	landing roll	☐	H

Part(s) of Aircraft

	Struck		Damaged†
radome	☐	18	☐
windshield	☐	19	☐
nose (excluding above)	☐	20	☐
engine no. 1	☐	21	☐
2	☐	22	☐
3	☐	23	☐
4	☐	24	☐
propeller	☐	25	☐
wing/rotor	☐	26	☐
fuselage	☐	27	☐
landing gear	☐	28	☐
tail	☐	29	☐
lights	☐	30	☐
other (specify)	☐	31	☐

Effect on Flight

none	☐	32
aborted take-off	☐	33
precautionary landing	☐	34
engines shut down	☐	35
other (specify)	☐	36

Sky Condition 37

no cloud	☐	A
some cloud	☐	B
overcast	☐	C

Precipitation

fog	☐	38
rain	☐	39
snow	☐	40

Bird Species* 41
(or size)

*No bird fragment (including feather) is too small to be useful but the larger the sample available the easier the task of identification. If you are not certain of the bird species please send remains to address overleaf.

Number of Birds

	Seen 42		Struck 43	
1	☐	A	☐	A
2 – 10	☐	B	☐	B
11 – 100	☐	C	☐	C
more	☐	D	☐	D

Pilot Warned of Birds 45

yes ☐ Y no ☐ N

Remarks (describe damage, injuries and other pertinent information; bird remains for identification) 46/47
†Photographs of damage would be welcomed by SDAU.

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THIS INFORMATION IS REQUIRED FOR AVIATION SAFETY

IMPORTANT

Pilots: *Hand to ATC at first available UK aerodrome.*

ATC: *Forward to Safety Data and Analysis Unit*

Others: (eg: engineering staff) *Hand to ATC or fold and post to:*
Civil Aviation Authority
Safety Data and Analysis Unit
Aviation House, South Area,
Gatwick Airport,
West Sussex RH6 0YR

CA 1282
030288

Reporter's:

Name ____________________

Name of Employer ____________________

Occupation ____________________

Contactable at (Tel. & Ext.) ____________________

Signature ____________________

Fold and Tuck In

Affix
Stamp

Civil Aviation Authority
Safety Data and Analysis Unit
Aviation House
South Area
Gatwick Airport
West Sussex RH6 0YR

Second Fold

First Fold

*Bird remains should be sent to:—

Ministry of Agriculture, Fisheries and Food
Aviation Bird Unit
Tangley Place
Worplesdon
Guildford
Surrey GU3 3LQ

Third Fold

ADF616016

Bird Strikes during 1985 to european registered civil aircraft

(J. Thorpe and I. Hole, UK)

BSCE 19 /WP 19

Madrid, 23-28 May 1988

BIRD STRIKE COMMITTEE EUROPE

BIRD STRIKES DURING 1985 TO EUROPEAN REGISTERED CIVIL AIRCRAFT

(Aircraft over 5700 kg Maximum Weight)

J Thorpe - UK
I Hole - UK

SUMMARY

The strikes reported throughout the World in 1985 by operators from twelve European countries have been analysed. The analysis includes rates for countries, aircraft types and aerodromes based on aircraft movements. It also covers bird species, part of aircraft struck, effect of strike, airlines affected and cost.

The strike rate in 1985 was at 4.6 per 10,000 movements, slightly lower than the 5.0 of 1984, probably due to one of the best reporting countries not being in a position to provide full information. Gulls (Larus spp.) were involved in 37% of the incidents. There were 16 cases where more than one engine suffered ingestion. The major effect was damage to 88 engines, and the cost was at least 35 million US dollars.

CONTENTS

This study is based on information supplied and the accuracy and detail are only as good as that reported. Any opinions expressed are those of the author.

1 INTRODUCTION

1.1 In order that a common basis for the analysis of bird strike data could be agreed, a Working Group of the Bird Strike Committee Europe was formed in 1972, led by the representative from the United Kingdom Civil Aviation Airworthiness Division at Redhill. Reports covering the individual years 1972 to 1984 inclusive have been presented to BSCE meetings. This paper contains the 1985 analysis.

1.2 Appendix 1 contains the Tables of data relating to this paper.

2 SCOPE

For the following reasons, the analysis includes all civil aircraft of over 5700 kg (12 500 lb) maximum weight, and executive jets which weigh just less than 5700 kg, eg Lear and Citation.

(a) the airworthiness requirements relating to bird strikes are different for the smaller class of aeroplanes,

(b) much more is known about the reporting standards of operators of transport types, and their movement data is more readily available than that for air taxi or private owner aircraft.

(c) aircraft of less than 5700 kg are in general, much slower with a different mode of operation, requiring less airspace, and a noticeably different strike rate would be expected.

3 DISCUSSION

3.1 Annual Rate/Country (See Table 1)

(a) Information has been obtained from a total of twelve European countries. A few of these were not able to provide full information, and their data therefore, appears in some tables and not in others.

(b) The overall strike rate for the 1387 incidents contained in this analysis is 4.6 per 10,000 movements (two movements per flight) This is less than the rate of 5.0 recorded during 1984 (5.6 in 1983). One of the most efficient reporting countries, Germany, is only partially included; this may have resulted in the apparent lowering of the rate.

(c) The strike rate reported by each country is dependent upon two major factors -

- reporting standard

- the bird strike problem at airports within that country, and that country's airlines route structure.

(d) The country with the highest reported strike rate and possible the most efficient reporting is Switzerland with 8.8 per 10,000 movements, followed by Austria with 7.5.

(e) The highest rates of damage has been reported by Czechoslovakia and France, while German registered aircraft are also thought to experience a hiqh rate of damage.

3.2 Aircraft Types (see Table 2)

(a) Jet Aeroplanes

(i) For several years there appears to have been no consistent correlation between aircraft of similar design, e.g. DC10 and L1011. It may be that aircraft which appear similar to humans are not similar to birds, and there are other factors such as noise patterns, which can affect the strike rate. There is some difference in the strike rate of 4, 3 and 2 engined jets.

(ii) The small sample of IL62, the DC10, B767, A300, A310 and Mercure have above average strike rates.

(iii) The aircraft with the greatest damage rate are DC10, A300, A310, TU134, DC8 and B747.

(iv) 21% of strikes to four engined jet powered aircraft cause damage while the average for all jets is 11%.

(b) Turboprop Aeroplanes

The average strike rate for all turboprops is 3.5 compared with 5.2 for jets.

(c) Helicopters

The number of strikes reported to helicopters is very low, only 17. Because helicopters fly mainly at low altitude where birds are most frequently found, they are continuously exposed to the risk of a strike. Therefore flying hours have been used to determine a strike rate. For reasons which are not at present known, but may be associated with their comparatively low speed and forward noise levels, the rate is low at 1.1 per 10,000 hours, the same as in 1984. There were two cases of damage.

3.3 Aerodromes (See Table 3)

(a) The aerodrome data is of particular importance as it may indicate where bird control measures need to be taken. Some countries were able to provide aerodrome movement data for their nationally registered aircraft, so that a national rate has been quoted.

The total number of strikes at each aerodrome, reported by all European sources has also been included.

(b) Strikes reported on aerodromes are influenced by one or more of the following.

(i) reporting standards

(ii) the prevailing bird situation which may vary according to place and time

(iii) the number of aircraft movements

(iv) the effectiveness of bird control measures

(v) local factors, perhaps beyond control of the aerodrome, e.g. a rubbish dump or bird roost site in the vicinity.

(c) Because of factors outlined in (b), direct comparison of the reported strike rates for different aerodromes could be misleading.

(d) European aerodromes with five or more damaging strikes at* the aerodrome are Paris CDG, Frankfurt and Hamburg. This may in some cases be a reflection of the aerodrome movements, local bird populations and reporting efficiency.

(e) Some aerodromes have a high number of strikes near* the airport in particular Prague, Paris CDG, Frankfurt and London Heathrow. This may be a reflection of the high number of movements by European registered airliners.

(f) Only Paris CDG reported many cases of damage near* the airport.

(g) Significant numbers of strikes have been reported at aerodromes outside Europe. Ten strikes were reported at Arusha (Tanzania). Four of the incidents at Nairobi and three at Monrovia resulted in damage.

3.4 Bird Species (See Table 5)

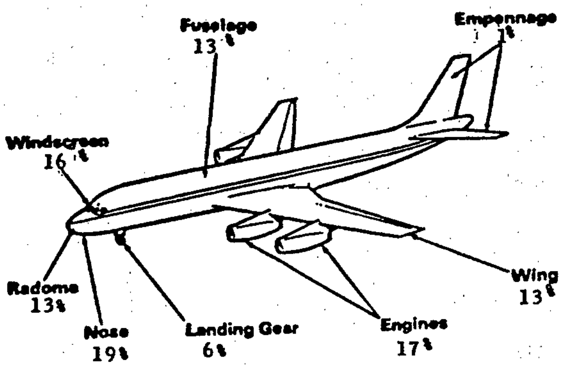
Some knowledge of the bird species involved was available in 61% of incidents. The identification standard ranged from examination of bird remains by a trained ornithologist to the fleeting glance of a pilot. Overall 37% of strikes involved gulls (Larus spp.) of which the Black-headed gull (Larus ridibundus) was the most frequently identified. This is similar to 1984. Next on the list was the Lapwing (Vanellus vanellus) with 13% and the combination of swift/swallow/martin at 16%. Birds of prey accounted for 12% compared with only 7% in 1984. Eight incidents were believed to involve a bird heavier than 1.81 kg (4lb).

The birds struck during the last ten years are summarised overleaf. There does not appear to be a clear trend.

Birds	YEAR 76	77	78	79	80	81	82	83	84	85
Gulls (Larus spp.)	44	41	41	41	41	45	33	35	41	37
Lapwing (Vanellus vanellus)	14	10	11	10	12	9	14	13	17	13
Birds of Prey (Falconiformes)	8	9	8	8	10	12	9	8	7	12
Pigeons (Columba spp.)	7	9	7	7	7	7	7	8	6	5
Swift/swallow/martin	11	12	13.5	18	15	11	13	18	11	16

* On - up to 500 ft in the climb and 200 ft and below on approach
Near - 501 to 1500 ft on climb and between 1000 ft and 201 ft on approach.

3.5 Part of Aircraft Struck (See Table 6)



From the figure the parts most frequently reported as being struck can be seen.

It should be noted that there were 16 incidents where more than one engine was struck, of which 5 affected all engines.

3.6 Effects of Strikes (See Table 7)

(a) During 1985 a total of 88 engines were damaged such as to require repair or replacement (39 less than in 1984). Of these 64 were on twin engined aircraft. It appears that 30% of reported engine strikes involved engine damage.

(b) Only seven windscreens were changed, a small number compared with the 273 windscreen strikes. None of these was known to involve penetration.

(c) There were 26 bases of radome damage, out of 236 radome strikes. In most cases the radome was only delaminated, but in a few cases it was shattered. The radome strength is limited by the need for dielectric properties enabling satisfactory operation of the weather radar.

3.7 Cost

Only three countries (Denmark, France, Netherlands) were able to provide cost information, from which it was estimated that the minimum cost to European airlines was 35 million US dollars.

3.8 Aircraft Operator Reporting (See Table 8)

This table provides a guide to the reporting efficiency and problems of individual airlines. It is probable that it is considerably affected by the airport(s) at which the airline has its main base.

4 CONCLUSIONS

4.1 The overall rate for the 1387 strikes reported during this period by European operators is 4.6 strikes per 10,000 movements. Probably due to a change in the reporting countries, this rate is slightly lower than in previous years.

4.2 There does not appear, from the available data, to be any close correlation between the strike rate and the aeroplane type in terms of speed, engine type etc.

4.3 Some aircraft for reasons which are unknown, have a much higher strike rate, whilst others have a higher rate of damage.

4.4 The percentage of strikes which cause damage to 4 engined jet powered aircraft is double that on 3 or 2 engined aircraft.

4.5 There are some airports outside Europe where the number of bird strikes reported by European operators is high even though movements by European registered aircraft at these airports are believed to be low. Damage occurred at several of these airports.

4.6 Gulls (Larus spp.) were struck more frequently than other birds, being involved in 37% of incidents where the bird species were known. Less than 1% of birds struck were believed to be greater than 1.8 kg (4 lb).

4.7 The nose section including the windscreen and radome were reported as being struck in 48% of incidents, with engines being struck in 17%. There were 16 incidents where more than one engine was struck.

4.8 The major consequences were damage to 88 engines. There were no aircraft written off, or occupants injured.

4.9 The estimated cost of European airlines is a minimum of 35 million US dollars.

APPENDIX 1

BIRD STRIKE ANALYSIS

EUROPEAN OPERATORS 1985

CIVIL AIRCRAFT OVER 5700 KG (12.500 lb) MAXIMUM WEIGHT

Notes:

0.1 The following are excluded from this Analysis:

(a) aircraft of maximum weight 5700 kg (12.500 lb) and under, except for those few executive jets, which have been included, eg Lear and Citation.

(b) all military type and operated aircraft.

0.2 All Tables are for strikes reported world-wide.

0.3 The Total columns of many of the Tables are different, as some countries have not been able to provide full information for every table.

0.4 There are two movements per flight.

0.5 Where the number of incidents, or number of movements are small, and particularly where they are both small, the derived rate should be treated with caution.

Table 1 National Reporting - 1985

(A high rate may be due to efficient reporting)

Reporting Nation	Number of Incidents World Wide	Damaging Incidents	Number of Movements World Wide	Rates per 10,000 Movements	
				Damage	All
Austria*	41	1	54,512	-	7.5
Belgium	31	6	112,750	0.5	2.7
Czechoslovakia*	33	8	50,494	1.6	6.5
Denmark	59	6	292,204	0.2	2.0
Finland	64	2	113,232	0.2	5.7
France	254	52	555,095	0.9	4.6
Germany	(354)	(55)	N/A	N/A	N/A
Italy*	48	3	99,000	0.3	4.8
Netherlands*	74	7	168,863	0.4	4.4
Sweden	92	6	262,005	0.2	3.5
Switzerland*	161	7	182,326	0.4	8.8
United Kingdom	530	34	1,118,754	0.3	4.7
Total	1387 (354)	132 (55)	3,009,235	0.4	4.6

Notes:

1.1 * Movement data for Austria, Czechoslovakia, Italy, Netherlands and Switzerland is from ICAO sources.

1.2 Helicopters are excluded from this Table.

1.3 The figures in brackets are strikes for which no movement data is available.

Table 2 Aircraft Type-1985

Aircraft	Number of Countries Reporting	Number of Strikes		Number of Movements	Strike Rate per 10,000 Movements	
		Damage	All		Damage	All
JET						
Ilyushin 62	1	1	10	9,952	-	10.0
BAe 146	1	-	9	14,396	-	6.3
McDonnel Douglas DC-8	6	3	10	16,373	1.8	6.1
Boeing 707/720	2	-	4	6,520	-	6.1
Boeing 747	8	23	94	196,649	1.2	4.8
Concorde	1	1	2	4,514	-	4.4
All 4 Engined Jets	-	28 (21%)	129	248,927	1.1	5.2
Yak 40	1	-	3	7,142	-	4.2
McDonnell Douglas DC10	10	12	112	110,758	1.1	10.1
Lockheed 1011 Tristar	2	2	33	50,566	0.4	6.5
HS Trident	1	-	16	28,558	-	5.6
Boeing 727	4	16	99	233,035	0.7	4.2
All 3 Engined Jets	-	30 (11%)	263	430,059	0.7	6.1
Tupolev 134	1	6	15	29,856	2.0	5.0
Boeing 767	1	-	10	9,302	-	10.8
DA01 Mercure	1	3	41	50,302	0.6	8.2
A300 Airbus	5	15	115	140,727	1.1	8.2
A310 Airbus	6	9	62	81,846	1.1	7.6
Boeing 757	2	2	33	50,566	0.4	6.5
Boeing 737	5	40	314	596,633	0.7	5.3
McDonnel Douglas DC-9	8	16	321	635,956	0.3	5.0
BAC 1-11	1	1	85	188,552	-	4.5
SE 210/212 Caravelle	2	2	27	65,586	0.3	4.1
Fokker F28	4	4	44	223,645	0.2	2.0
Cessna 500/550 Citation	3	-	1	3,768	-	-
DA20 Falcon	4	-	-	2,286	-	-
HS125	1	1	8	50,000 (EST)	-	1.6
Learjet	3	1	1	4,928	-	-
SN 601 Corvette	1	-	-	2,500	-	-
All 2 Engined Jets	-	100 (9%)	1077	2,136,453	0.5	5.0
ALL JETS	-	158 (11%)	1469	2,815,439	0.6	5.2
TURBOPROP						
Illyushin 18	1	-	3	2,932	-	10.2
BAC Viscount	1	-	20	41,728	-	4.8
DHC Dash 7	2	-	3	30,272	-	0.1
Short Belfast	1	-	1	862	-	-
BAC Merchantman	1	-	1	5,264	-	-
HS Argosy	1	-	-	1,514	-	-
All 4 Engine Turboprops	-	-	28	82,572	-	3.4
Let 410	1	1	2	612	16.3	32.7
Fokker F27/227	6	3	20	127,682	1.8	6.1
Short SD 330/360	2	2	72	121,266	0.2	5.9
HS 748	2	3	28	77,458	0.4	3.6
HP Herald	1	-	5	15,108	-	3.3
Nord 262	1	1	2	9,570	1.0	2.1
BAE Jetstream 31	1	-	4	20,672	-	1.9
SAAB SF-340	3	-	1	6,718	-	1.5
ATR 42	1	-	-	6,942	-	-
All 2 Engine Turboprops	-	10	134	386,028	0.3	3.5
ALL TURBOPROPS	-	10	162	468,600	0.2	3.5

PISTON						
Bristol 170 Freighter	-	-	-	640	-	-
Douglas DC3 Dakota	1	1	-	1,266	-	-
ALL PISTON	-	1	-	1,906	-	-
UNKNOWN	-	-	-	-	-	-
TOTAL	-	169	1631	3,284,039	0.5	5.0
HELICOPTERS						
Sikorsky S61	2	-	9	55,192	-	1.6
Boeing 234 Chinook	1	-	-	5,666	-	-
AS332L Puma	1	-	4	47,882	-	0.8
Bell 212/214	2	2	3	42,238	-	0.5
Westland WG 30	1	-	2	3,276	-	6.1
ALL HELICOPTERS	-	2	18	154,254	-	1.1

Notes: 2.1 Because of the low altitude of operation, and difficulty in collection of movement data, helicopter operations are quoted in hours.

2.2 The figures in brackets are for aircraft for which movement data is unavailable.

2.3 Where the number of incidents, or the number of movements is small and particularly where they are both small any derived rate should be treated with caution.

TABLE 3 AERODROMES - 1985

(A high rate may be due to efficient reporting)

Definition - up to 500ft on climbe
- 200ft and below on approach

Country/Aerodrome	Incidents	Movements	Rate per 10,000 Movements	Incidents to Other European Aircraft	Total Damage	Total All
AUSTRIA						
Klagenfurt	1	-	-	-	-	1
Salzburg	1	-	-	2	-	1
Vienna	14	-	-	2	1	16
Graz	1	-	-	-	-	1
BELGIUM						
Antwerp	1	-	-	-	-	1
Brussels	5	-	-	5	3	10
Charleroi	1	-	-	-	-	1
CZECHOSLOVAKIA						
Bratislava	3	15,561	3.8	-	2	6
Kosice	1	4,594	-	-	-	1
Prague	13	39,106	3.3	-	2	13
Poprad	1	12,751	-	-	-	1
DENMARK						
Aalborg	1	-	-	2	-	3
Billund	3	-	-	-	1	3
Copenhagen	8	61,874	2.7	19	4	27
Esbjerg	6	-	-	-	-	6
Odense	1	-	-	-	-	1
Ronne	2	-	-	-	-	2
Roskilde	1	-	-	-	-	1
Sonderborg	1	-	-	-	1	1
Stauning	1	-	-	-	-	1
Thisted	1	-	-	-	-	1
Tristrup	1	-	-	4	-	5
FINLAND						
Helsinki - Vantaa	13	61,138	2.1	-	1	13
Kajaani	6	1,316	45.6	-	-	6
Kemi	3	3,078	9.7	-	-	3
Kuopio	1	5,582	-	-	-	1
Mariehamn	4	4,178	9.6	-	-	4
Oulu	2	9,612	2.1	-	-	2
Pori	1	2,906	-	-	-	1
Turku	1	10,672	-	-	-	1
Varkaus	2	1,668	12.0	-	-	2
FRANCE						
Aix - Le Milles	1	-	-	-	-	1
Aurillac	1	826	-	-	1	1
Bale Mulhouse	2	7,998	2.6	-	-	2
Bastia	4	7,323	5.4	-	-	4
Beauvais - Tille	1	42	-	2	-	3
Bezier	1	198	-	-	-	1
Biarritz	8	3,525	22.7	-	1	8
Brest	5	6,850	7.3	-	-	5
Cannes	1	299	-	-	-	1
Chambery	1	1,897	-	-	-	1
Cherbourg	1	716	-	-	1	1
Clermont Ferrand	2	7,403	2.7	-	-	2
Coltair - Houssen	1	904	-	-	-	1
Epinal - Mire Court	1	927	-	-	1	1
Hyenes - Le Octeville	3	2,743	10.9	-	-	3
Grenoble - St Geoirs	1	4,496	-	-	-	-
La Rouchelle	1	1,120	-	-	-	1
Lille	2	8,857	2.2	-	-	2
Le Harve	5	959	52.1	-	-	5
Le Puy Loudes	1	894	-	-	-	1
Lorient - Lan Bihou	5	1,967	25.4	-	-	5
Lourdes	10	1,548	64.6	-	2	10
Lyon - Satolas	8	38,066	2.1	1	1	9
Marseilles	8	37,567	2.1	2	-	10
Merville - Calonne	1	-	-	-	-	1
Montlucon - Dumerat	1	-	-	-	-	1
Montpellier	4	10,035	4.0	-	1	4
Morlaix - Ploujean	2	900	22.2	-	2	2

Nantes	2	13,445	3.5	-		2
Nice - Cote d'Azur	12	35,777	3.3	-	3	12
Nimes - Garons	1	2,582	-	-	-	1
Paris - Charles de Gaulle	25	64,606	3.9	4	5	29
Paris - Le Bourget	5	-	-	-	2	5
Paris - Orly	32	118,892	2.7	1	2	33
Pau/Pont	3	6,287	4.7	-	-	3
Perpignan	3	2,833	10.4	-	-	3
Pleurtuit	2	984	20.3	-	1	2
Quimper	1	2,270	-	-	-	1
Rennes - St Jacques	1	2,855	-	-	-	1
St Brieul	1	2,035	-	-	1	1
St Etienne	2	2,135	9.3	-	-	2
St Yan	6	-	-	-	-	6
Strasbourg	1	10,229	-	-	-	1
Toulouse - Blagnac	14	17,865	7.8	3	3	17
GERMANY						
Berlin	-	-	-	5	-	5
Cologne - Bonn	-	-	-	5	-	5
Dusseldorf	-	-	-	4	4	8
Francfurt A.M.	-	-	-	-	7	7
Geilenkirchen	-	-	-	1	-	1
Hamburg	-	-	-	3	7	9
Hannover	-	-	-	-	1	1
Lechfeld	-	-	-	-	-	1
Munchen	-	-	-	2	4	6
Munich	-	-	-	1	-	1
Munster	-	-	-	-	2	2
Nurnberg	-	-	-	-	1	1
Stuttgart	-	-	-	1	2	2
IRELAND						
Dublin	-	-	-	3	-	3
ITALY						
Bologna	1	-	-	-	-	1
Brindisi	1	-	-	-	-	1
Cagliary	1	-	-	-	-	1
Genoa	3	-	-	2	1	5
Milan - Linate	4	-	-	1	2	5
Milan - Malpensa	1	-	-	-	1	1
Olbia	2	-	-	-	1	2
Palermo	1	-	-	-	-	1
Piza	1	-	-	-	-	1
Rome - Fiumicino	5	-	-	6	-	11
Ronchi	1	-	-	-	-	1
Venice	1	-	-	2	-	3
NETHERLANDS						
Amsterdam	20	61,990	3.2	14	3	34
Curacao	-	-	-	2	-	2
Eindhoven	-	-	-	1	-	1
Rotterdam	2	3,942	5.1	-	-	2
NORWAY						
Alta	-	-	-	2	-	2
Bergen	-	-	-	2	1	2
Oslo - Fornebu	-	-	-	2	-	2
Sola	-	-	-	1	-	1
POLAND						
Warsaw	-	-	-	1	-	1
PORTUGAL						
Funchal	-	-	-	1	1	1
Lisbon	-	-	-	8	1	8
Porto	-	-	-	3	2	3
SPAIN						
Alicante	-	-	-	1	1	1
Barcelona	-	-	-	1	-	1
Malaga	-	-	-	4	2	4
Mahon	-	-	-	2	-	2
Palma	-	-	-	5	2	5
Reus	-		-	5	-	5

SWEDEN						
Angelholm	2	5,428	3.7	-	-	2
Gothenburg - Landvetter	4	37,038	1.1	1	-	4
Halmstad	2	3,200	6.3	-	-	2
Kalmar	5	6,494	7.7	1	1	7
Karlstad	2	4,580	4.4	-	-	2
Kristianstad	3	3,052	9.8	-	-	3
Malmo - Sturup	3	16,230	1.8	-	-	3
Stockholm - Arlanda	18	162,800	1.1	4	-	22
Sundsval	2	11,734	1.7	-	-	2
Umea	3	11,820	2.5	-	2	3
Vasteras Hasslo	2	2,122	9.4	-	-	2
Vaxjo	2	5,590	3.6	-	-	2
Visby	6	10,598	45.7	-	-	6
SWITZERLAND						
Basle - Mulhouse+	3	31,386	0.9	-	-	3
Geneva	7	74,208	0.9	2	-	9
Zurich	31	128,230	2.4	2	-	33
UNITED KINGDOM						
Aberdeen	11	68,773	1.6	-	1	11
Bangor	-	-	-	1	-	1
Belfast Aldergrove	29	25,269	11.5	-	3	29
Belfast Harbour	5	8,582	5.8	-	-	5
Birmingham	22	26,925	8.1	1	2	23
Blackpool	5	13,619	3.7	-	-	5
Bristol - Lulsgate	8	7,911	10.1	-	-	8
Cardiff - Wales	7	7,484	9.4	-	-	7
Coventry	-	-	-	1	-	1
East Midlands	10	21,001	4.8	-	-	10
Edinburgh	11	28,498	3.9	-	1	17
Exeter	2	-	-	-	-	2
Glasgow	6	39,253	2.0	-	-	8
Humberside	2	-	-	-	-	2
Kirkwall	2	-	-	-	-	2
Leeds - Bradford	11	11,711	9.4	-	1	12
Liverpool	11	17,077	6.4	-	-	11
London Gatwick	9	93,535	1.0	-	1	9
London Heathrow	32	145,987	2.2	9	3	41
London Stansted	7	15,821	4.4	-	-	7
Luton	18	22,041	8.2	-	4	18
Lydd	4	3,345	12.0	-	-	4
Manchester	30	49,570	6.1	1	1	31
Newcastle	14	17,598	8.0	-	1	14
Norwich	4	16,337	2.4	-	-	4
Oil Rigs	9	-	-	-	-	9
Ronaldsway I of M	32	12,659	25.3	-	-	32
Southend	3	7,769	3.9	-	-	3
Sumburgh	3	12,810	2.3	-	-	3
Tees-side	7	9,211	7.6	-	1	7
Warton	1	-	-	-	1	1
USSR						
Moscow	-	-	-	1		1

LIST OF AERODROMES WHERE MORE THAN ONE STRIKE, OR ONE STRIKE WITH DAMAGE HAS BEEN REPORTED BY EUROPEAN OPERATORS, Damaging strikes in brackets.

Other Aerodromes

Accra (Ghana)	2
Alger (Algeria)	3
Arusha (Tanzania)	10
Bamako (Mali)	2
Bangui - M'Poko (Rep. of Central Africa)	2 (2)
Bangkok (Thailand)	2 (1)
Banjul (Gambia)	2 (1)
Barbados	1 (1)
Bombay (India)	2 (1)
Casablanca (Marocco)	3 (1)
Corfu (Greece)	3
Dakar (Senegal)	1 (1)
Delhi (India)	3 (1)
Freetown (Sierra Leone)	2
Guernsey (UK)	15
Hong Kong	2
Istanbul (Turkey)	5 (1)
Jakarta (Indonesia)	2 (1)
Jersey (UK)	6 (1)
Johannesbourg (South Africa)	3 (1)
Juba (Sudan)	1 (1)
Kano (Nigeria)	3
Lagos (Nigeria)	5
Libreville (Gabon)	3
Los Angeles (USA)	2 (1)
Malta	3
Monrovia (Liberia)	3 (3)
Montevideo (Uruguay)	1 (1)
Nairobi (Kenya)	2 (4)
Ouagadougou (Burkina Faso)	1 (1)
Rio de Janeiro (Brazil)	6 (2)
Sao Paulo (Brazil)	2 (1)
Shangi (Singapore)	3 (1)
Tahiti	1 (1)
Tangier (Morocco)	1 (1)
Tokyo (Japan)	2 (1)
Tunis (Tunisia)	1 (1)
En Route	71 (18)
Unknown	32 (3)

Notes: 3.1 Because of the variability in reporting, bird population, aircraft movement pattern, control measures and features beyond control, any comparison between the rates calculated for different aerodromes is likely to be misleading.

3.2 Germany did not report non-damaging strikes

TABLE 4 INCIDENTS NEAR AERODROMES - 1985

Definition - Between 501ft and 1500ft on climb
- Between 1000ft and 201ft on approach

Country/Aerodrome	Incidents	Movements	Rate per 10,000 Movements	Incidents to Other European Aircraft	Total Damage	Total All
AUSTRIA						
Salzburg	-	-	-	1	1	1
BELGIUM						
Brussels	3	-	-	-	-	3
BULGARIA						
Burgas	-	-	-	1	-	1
CYPRUS						
Larnaca	-	-	-	1	-	1
CZECHOSLOVAKIA						
Bratislava	4	15,561	2.6	-	-	4
Ostrava	1	4,197	-	-	1	1
Prague	11	39,106	3.1	1	3	12
DENMARK						
Aalborg	1	-	-	-	-	1
Copenhagen	3	61,874	0.6	1	1	4
FINLAND						
Helsinki - Vantaa	2	61,138	0.3	-	-	2
Joesuu	1	3,124	-	-	-	1
Turku	1	10,672	-	-	-	1
FRANCE						
Bastia - Poretta	1	7,323	-	-	-	1
Marseille	1	37,567	-	-	-	1
Paris - Charles de Gaulle	5	64,606	1.4	4	2	9
Paris - Orly	3	118,898	0.3	-	1	3
St Yan	1	-	-	-	1	1
Toulouse - Blagnac	1	17,865	-	-	-	1
GERMANY						
Cologne - Bonn	-	-	-	1	-	1
Dusseldorf	1	-	-	-	1	1
Frankfurt	7	-	-	-	7	7
Hambourg	4	-	-	-	4	4
Munchen	2	-	-	-	2	2
Nurnberg	1	-	-	-	2	2
Stuttgart	1	-	-	-	1	1
IRELAND						
Dublin	-	-	-	1	-	1
ITALY						
Milan - Linate	2	-	-	2	-	4
Milan - Malpensa	1	-	-	-	-	1
Rome - Fiumicino	3	-	-	-	-	3
Venice	3	-	-	-	-	3

SPAIN						
Ibiza	-	-	-	1	-	1
Malaga	-	-	-	2	-	2
Palma	-	-	-	1	-	1
SWEDEN						
Gotenborg - Landvetter	-	37,038	-	1	-	1
Stockholm - Arlanda	-	162,800	-	1	-	1
Kalmar	-	6,494	-	1	-	1
UNITED KINGDOM						
Aberdeen	1	68,773	-	-	-	1
E. Midlands	1	21,001	-	-	-	1
Glasgow	4	39,253	1.0	-	1	4
London - Gatwick	1	93,535	-	-	-	1
London - Heathrow	7	145,987	0.5	-	-	7
Luton	1	22,041	-	-	1	1
Manchester	1	49,570	-	1	-	2
U.S.A.						
New York - J.F.K	-	-	-	2	-	2

TABLE 5 BIRD SPECIES - 1985

Scientific Name	English Name	Weight/Weight Category: Weight	Weight/Weight Category: Category	Number of Incidents: Damage	Number of Incidents: Total	% Based on 1001
PODICIPEDIFORMES						
Podicipedidae	Grebe	150 g - 990 g	B	-	1	-
PELICANIFORMES						
Phalacrocorax sp.	Cormorant	1.7 kg - 2.7 kg	C	1	1	-
CICONIIFORMES						
Ardea sp.	Heron	500 g - 4.5 kg	B	-	1	-
Ardea cinerea	Grey heron	up to 1.5 kg	B	1	3	0.3
Bubulcus ibis	Cattle egret	345 g	B	2	7	0.7
Eudocimus albus	White ibis	830 g	B	-	1	-
ANSERIFORMES						
Anas sp	Duck	250 kg - 1.3 kg	B	-	6	0.6
Anas platyrhynchos	Mallard	1.1 kg	B	1	3	0.3
Anser sp.	Goose	1.8 kg - 4 kg	C	2	4	0.4
Cygnus sp	Swan	4.7 kg - 12 kg	D	-	2	0.2
FALCONIFORMES						
Falconiformes	Bird of Prey	105 g - 1.3 kg	B	1	29	2.9
Milvus sp	Kite	780 g - 1.0 kg	B	2	4	0.4
Milvus migrans	Black kite	780 g	B	2	9	0.9
	"Hawk"	up to 1 kg	B	-	3	0.3
Accipiter nisus	Sparrow hawk	190 g	B	-	6	0.6
Accipiter gentilis	Goshawk	1.0 kg	B	1	2	0.2
Buteo sp	Buzzard	260 g - 1.3 kg	B	8	26	2.6
Buteo buteo	Common buzzard	800 g	B	2	16	1.6
Falco tinnunculus	Kestrel	200 g	B	4	26	2.6
GALLIFORMES						
Tetrao tetrix	Black grouse	1.1 kg	B	-	3	0.3
Lyrurus tetrix	Common black grouse		B	-	1	-
Phasianus colchicus	Pheasant	1.1 kg	B	-	2	0.2
Alectoris rufa	Red-legged partridge	450 g	C	-	1	-
Perdix perdix	Grey partridge	400 g	B	3	8	0.8
GRUIFORMES						
Tetrax tetrax	Little bustard	180 g	B	-	1	-
CHARADRIIFORMES						
Larus sp	Gull	280 g - 1.7 kg	B	23	216	21.6
Larus marinus	Great black backed gull	1.7 kg	B	-	2	0.2
Larus fuscus	Lesser black backed gull	820 g	B	-	4	0.4
Larus argentatus	Herring gull	1.0 kg	B	3	31	3.1
Larus canus	Common gull	420 g	B	2	22	2.2
Larus delawarensis	Ring-billed gull	485 g	B	-	1	-
Larus ridibundus	Black-headed gull	275 g	B	15	93	9.3
Haematopus ostralegus	Oystercatcher	500 g	B	-	3	0.3
Pluricalis apricaria	Golden plover	185 g	B	-	2	0.2
Vanellus vanellus	Lapwing	215 g	B	12	127	12.7
Numenius arquata	Curlew	770 g	B	-	4	0.4
Scolopax rusticola	Woodcock	300 g	B	1	1	-
Calidris alpina	Dunlin	50 g	A	-	1	-
COLUMBIFORMES						
Columba sp	Pigeon	up to 465 kg	B	6	36	3.6
Columbia oneas	Stock dove	345 g	B	-	3	0.3
Columba livia	Rock dove	395 g	B	3	3	0.3
Columba palumbus	Woodpigeon	465 g	B	2	9	0.9
CUCULIFORMES						
Cuculus canorus	Cuckoo	105 g	A	-	1	

STRIGIFORMES						
Strix sp	Owl	160 g - 380 g	B	1	12	1.2
Tyto alba	Barn owl	315 g	B	1	4	0.4
Athene alba	Little owl	164 g	B	-	1	-
Asio otus	Long-eared owl	275 g	B	-	1	-
APODIFORMES						
Apus apus	Swift	40 g	A	-	31	3.1
PASSERIFORMES						
Passeriformes	Swallow/Martin	20 g	A	-	6	0.6
Alauda arvensis	Skylark	40 g	A	-	17	1.7
Lullula arborea	Woodlark	27 g	A	-	1	-
Galerida cristata	Crested lark	40 g	A	-	1	-
Hirundo rustica	Swallow	19 g	A	2	112	11.2
Caprimulegus europaeus	Nightjar	45 g - 100 g	A	-	1	-
Delica urbica	House martin	17 g	A	-	7	0.7
Corvus sp	Crow	up to 530 g	B	2	12	1.2
Corvus frugilegus	Rook	430 g	B	1	3	0.3
Pica pica	Magpie	220 g	B	-	2	0.2
Turdus sp	Thrush	60 g - 125 g	A	-	4	0.4
Turdus pilaris	Fieldfare	98 g	A	-	1	-
Turdus merula	Blackbird	100 g	A	-	7	0.7
Turdus philomelos	Song thrush	50 g - 107 g	B	-	3	0.3
Turdus iliacus	Redwing	70 g	A	-	2	0.2
Anthus pratenses	Meadow pipit	18 g	A	-	1	-
Sturnus vulgaris	Starling	80 g	A	-	29	2.9
Cardvelis spinus	Siskin	-	-	-	1	-
Passer domesticus	House sparrow	40 g	A	-	2	0.2
	Sparrow	18 g - 40 g	A	-	13	1.3
Fringilla coelebs	Chaffinch	15 g - 31 g	A	-	1	-
Cardvelis cannabina	Linnet	18 g	A	-	1	-
UNKNOWN				34	639	
TOTAL				138	1640	

Notes: 5.1 Bird weights and Scientific Names are based on 'Average Weights of Birds' by T Brough of Aviation Bird Unit, Worplesdon Laboratory, Agricultural Science Service, MAFF, Worplesdon, England. The average weight has been assumed.

5.2 The bird Categories based on current Civil Airworthiness requirements are:

A below 110 g (1/4 lb)
B 110 g to 1.81 g (1/4 lb to 4 lb)
C over 1.81 kg to 3.63 g (4 lb to 8 lb)
D over 3.63 kg (8 lb)

5.3 Those birds not positively identified are tabled as Unknown. Except where there is evidence that they are Large (C or D).

5.4 Percentages are based on incidents where birds are identified.

TABLE 6 PART OF AIRCRAFT STRUCK - 1985

INCIDENTS / PART STRUCK	BIRD WEIGHTS unknown	below 110kg	110g to 1.81kg	over 1.81kg	TOTAL	% BASED ON 1742
Fuselage	65	48	107	9	229	13.1
Nose (excluding radome and windshield)	113	79	126	7	325	18.7
Radome	78	69	83	6	236	13.5
Windscreen	88	82	96	7	273	15.7
Propeller	4	1	22	1	28	1.6
1 engine struck	81	42	148	6	277	15.9
2 out of 3 struck	-	1	4	-	5	0.3
2 or more of 4 struck	2	-	4	-	6	0.3
all engines struck	-	-	5	-	5	0.3
Wing / Rotor	51	33	147	5	236	13.5
Landing Gear	17	7	74	3	101	5.8
Empennage	8	1	12	-	21	1.2
Part unknown	53	32	145	2	232	-
TOTAL	560	395	973	46	1974	100.0

Notes: 6.1 The totals in Table 5 are higher than other tables as several parts can be struck in one incident.

6.2 The percentages are based on incidents where the part struck is known

6.3 Where both landing gear or both wings are struck, two incidents are recorded

6.4 110g = 1/4lb, 1.81kg = 4lb, 3.63kg = 8lb.

6.5 No data on parts struck available from Netherlands.

TABLE 7 **Effect of Strike - 1985**

Effect \ Bird Weight	Bird Weights: Unknown	Below 110 gm	110 gm to 1.81 kg	1.81 kg to 3.63 kg	Over 3.63 kg	Total	% Based on 1035
Loss of life/aircraft	-	-	-	-	-	-	-
Flight crew injured	-	-	-	-	-	-	-
Engine repairs on:							
2 engined aircraft	17	1	45	1	-	64	6.2
Others	16	-	7	1	-	24	2.3
Windscreen cracked or broken	3	1	2	1	-	7	0.7
Vision obscured*	-	-	1	-	-	1	0.0
Radome changed	8	1	15	1	1	26	2.5
Deformed structure	1	-	1	-	-	2	0.2
Skin torn/light glass broken	4	2	15	-	-	21	2.0
Skin dented*	22	-	16	1	-	39	3.8
Propeller/Rotor/transmission damaged	-	-	2	-	-	2	0.2
Aircraft system lost	1	-	5	-	-	6	0.6
Take off abandoned*	5	1	23	1	-	30	2.9
Nil damage	239	224	338	11	1	813	78.6
Unknown	-	3	8	2	-	13	-
TOTAL	316	233	478	19	2	1048	100.0

Notes: 7.1 If, for example, skin is torn in two places, or both windscreens are broken, two incidents are recorded.

7.2 The percentages are based on known effects.

7.3* Not counted as damage.

7.4 No data on strike effect available from Netherlands.

Table 8 Aircraft Operators - 1985

OPERATOR	NUMBER OF INCIDENTS	NUMBER OF MOVEMENTS	RATE PER 10,000 MOVEMENTS
AUSTRIA			
Austrian Airlines	41	38,226	10.7
BELGIUM			
Sabena	29	75,888	3.8
Sobelair	2	8,604	2.3
CZECHOSLOVAKIA			
CSA	33	50,494	6.5
SLI	2	612	32.7
DENMARK			
Cimber Air	2	18,540	1.1
Conair	4	8,030	5.0
Gronslandsfly	-	33,646	-
Maersk Air	6	57,202	1.0
SAS	29	92,944	3.1
Sterling Airways	2	27,752	0.7
Other	13	26,908	4.8
FINLAND			
Finnair Oy	60	124,456	4.8
FRANCE			
Air France	97	309,278	3.1
Air Inter	145	162,188	8.9
Etat	15	-	-
U.T.A.	8	15,514	5.1
T.A.T.	5	83,184	0.6
Taxis	8	-	-
Others	24	-	-
NETHERLANDS			
KLM	74	168,863	4.4
SWEDEN			
SAS	52	126,787	4.1
Linjeflyg AB	38	130,000	2.9
Swedair	2	5,218	3.8
SWITZERLAND			
Swissair	155	-	-
Balair	11	-	-
Omo	1	-	-
UNITED KINGDOM			
Air Atlantique	1	1,400	-
Air Bridge Carriers	1	5,264	-
Air Ecosse	3	13,590	2.2
Air Europe	7	13,556	5.2
Air Luton	1	-	-
Air UK	26	93,950	2.8
Airways Int (Cymru)	4	5,192	7.7
Anglo Cargo	-	502	-
Birmingham Executive	2	9,768	2.0
Bristow Helicopters	7	17,086 hrs	-
Britannia Airways	64	62,972	10.1
British Aerospace	4	-	-
Brittish Air Ferries	7	23,758	2.9
British Airways	143	403,528	3.5
British Airways Helicopters	5	27,543 hrs	1.8
British Caledonian Airways	41	63,432	6.5
British Caledonian Charter	2	3,663	5.5
British Caledonian Helicopters	2	9,834 hrs	2.0
British Island Airways	-	9,060	-
British Midland Airways	32	74,748	4.3
Brymon Airways	2	11,838	1.7
Channel Express	-	5,988	-
Dan-Air Services	57	129,202	4.4

Dravidian	2	-	-
Euroair Transport	1	2,470	-
Euroflight	-	2,992	-
Ford	2	-	-
Goodman/MAM	1	244	-
Guernsey Airlines	3	4,554	6.6
Heavy Lift Cargo	-	862	-
Janus	4	-	-
Jersey European	2	8,554	2.3
Loganair	6	12,400	4.8
London European	-	1,970	-
Manx Airlines	37	22,312	16.6
McAlpine	2	-	-
Metropolitan Airways	4	8,120	4.9
Monarch Airlines	8	19,848	4.0
North Scottish Helicopters	-	6,648 hrs	-
Orion Airways	6	18,946	3.2
Peregrine	1	1,626	-
Spacegrand	5	-	-
Tradewinds Airways	-	1,988	-
Virgin Atlantic	-	1,210	-
Other Operators	10	-	-
Unknown	14	-	-

Note: 8.1 Leased aircraft are included against the operator.

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Evaluation of bird populations at spanish airports: outline and results. Index

(Pablo Morera, Spain)

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EVALUATION OF BIRD POPULATIONS AT SPANISH AIRPORTS : OUTLINE AND RESULTS

INDEX

EVALUATION OF BIRD POPULATIONS AT SPANISH AIRPORTS : OUTLINE AND RESULTS

ABSTRACT

The general context of the bird problem at Spanish airports is described. The airports are then classified according to their bird populations, and the methodology and the results of the various studies are explained. The primary conclusions include:

1) the distinction between four groups of airports-Inland; Cantabria and Galicia; Mediterranean; and the Canary Islands-,
2) the main problems arise from wintering birds,
3) agricultural land use and rubbish dumps are two negative factors which affect the majority of the airports and
4) these studies are extremely valuable tools for establishing adequate corrective measures.

1.- INTRODUCTION

Accumulated experience on the bird strike hazard at airports has shown the importance of analytical studies that examine the factors causing this risk. As a generalization, the danger may be said to come from the abundance and behaviour of birds, as well as the air traffic itself. Given that the latter as a constant factor, only the number and the behaviour of birds can be considered as variable in the effort to reduce risks. It is thus important to understand the different bird problems, distinguish the species involved, and discover the causes of their behaviour.

The Spanish Airports Authority is aware of this, and has carried out a series of studies on bird populations at the most affected airports.

This paper attempts to (1) Place the airport strike hazard in a wider context that largely explains the birds presence, (2) Classify the national airports in terms of their individual circumstances, and (3) Set out the results obtained in these studies.

2.- GENERAL CONTEXT OF THE BIRD PROBLEM AT SPANISH AIRPORTS

Due to its geographical position and its special characteristics, Spain is one of the largest bird reserves in Europe (fig. 1). In addition to the large number of reproductory species here, many migratory birds come in spring and autumn. Certain areas also serve as wintering zones.

There are three migratory routes that affect airports to varying degrees:

- The Atlantic route, following the North and West coastlines, involving multitudes of marine birds and waders. Its effect is felt at the Cantabrian airports, where numerous species appear in autumn.

- The Mediterranean route, running parallel to the coast, and involving a large contigent of flamingos, birds of prey, ducks, waders and small species. It mainly affects airports near wetlands, like Barcelona, where large numbers of migratory species settle.

- The Inland route, less well-defined than the others. It covers the whole Iberian Peninsla, and is uses mainly by Wood Pigeons and Stone Curlews.

The three routes converge on the Gibraltar Strait area, where spectacular numbers of birds are found in the migration periods.

Some species, in contrast to those mentioned above, do not follow fixed routes and may appear anywhere on the Peninsula or the islands during migration. These are known as wide front migrants.

All these birds look for wintering areas with a benign climate and abundant food. Spain is again an excellent refuge, along with the other Mediterranean countries (fig. 2), for large numbers of birds. This situation is patently clear when a cold spell hits Central Europe and many species flee southwards.

In addition, Spain is an important breeding ground for many species that find ideal conditions to raise their young in large numbers here.

All these characteristics affect many Spanish airports, where large numbers of birds gather on or around their runways.

3.- CLASSIFICATION OF SPANISH AIRPORTS ACCORDING TO THEIR BIRD PROBLEM

The geographical distribution of Spain's airports derives from the country's socio-economic pattern of development. Of the 38 airports and military bases open to civilians air traffic, almost three-quarters (28) are on or near the coast. The remaining 25 % are inland. This fact determines the type of bird problem in many cases.

These airports may be classified in four categories, depending on large-scale external factors, especially their position and climate.

1) Inland. This includes the ten airports without a direct coastal influence. They are Vitoria, Pamplona, Zaragoza, Valladolid, Madrid-Barajas, Badajoz, Cordoba, Sevilla and Granada. Their problems mainly derive from steppeland birds.

2) Cantabria and Galicia. Seven airports are squarely on the Atlantic migratory route. These are San Sebastian, Bilbao, Santander, Asturias, La Coruña, Santiago de Compostela and Vigo. Waders, especially Lapwings, Snipes and Golden Plovers, seagulls and Starlings cause most of the problems in winter, and are more noticeable when a cold spell hits Europe.

3) Mediterranean. This is the largest and most diverse region. It includes 14 airports whose common denominator is their location on the Mediterranean migratory route. They are Reus, Gerona, Barcelona, Sabadell, Valencia, Alicante, San Javier, Malaga, Almeria, Jerez de la Frontera, Melilla, Menorca, Palma de Mallorca and Ibiza. Black-headed gulls, Stone Curlews, and Starlings are very common migrants and winter visitors. Herring Gulls also cause serious problems at airports located near their breeding grounds

in the northerns half of the region.

4) Canary Islands. This category includes the seven remaining airports: Lanzarote, Fuerteventura, Las Palmas, Tenerife Norte, Tenerife Sur, La Palma and Hierro. Only seagulls cause serious problems here. Due to their geographical position, these airports are not affected by bird flows due to cold spells in Europe.

4.- POSITION OF THE SPANISH AIRPORTS AUTHORITY IN THE STUDY OF THE BIRD PROBLEM

4.1.- Selection of case studies

On the basis of the reports, the Laboratory Services of the Spanish Airports Authority has classifed the 38 Spanish airports according to their risk factor. A total of 19 have bird problems.

The first stage in the search of radical solutions was the commssioning of serious studies of the matter. To date, 11 airports have been or are being studied. These are Vigo, Bilbao, Ibiza, Menorca, Palma de Mallorca, Santander, Tenerife Sur, Barcelona, Sevilla, Malaga and Madrid-Barajas. Three, Asturias, Vitoria and San Sebastian, expect to do so this year.

The five remaining airports, Almeria, Granada, La Palma, Lanzarote, and Tenerife Norte have sporadic problems that are being monitored but do not warrant in-depth studies for the moment.

The airports have been selected in order to combine the necessity for information on the most difficult cases with the desire for a general vision of the problems affecting each of the four regions mentioned in part 3.

4.2.- Methodology

The methodology used in these studies was presented at the last meeting of the European Bird Strike Committee in Copenhagen in 1986 (Ruiz, J. and Morera, P.: <u>Study structure of birds and ecosystems in Spanish airports</u>. It

basically includes the following aspects :

a) Classification of airport ecosystems. Special emphasis was placed on the collection of data on the composition and structure of vegetation, and the management of each airport's ecosystem. This permitted an analysis of their bird carrying capacity.

b) Study of resident communities. Using regular transect census, the composition and density of the bird communities in each of the previosuly defined ecosystems was evaluated.

c) Gregariousness. The social behaviour of each species indirectly affects its danger to air traffic. Data was collected on the annual changes in average flock size of the main species.

d) Bird flows. Areas with an intense bird flow were determined from observatories within or nearby the airport compound. Monthly and hourly variation, height and species involved in these flights were noted.

e) Main resting places. The areas with the largest clusters of birds were determined using the same technique. Their causes, such as the search for food, rest etc, their seasonal behaviour, including times and months of highest density, and the species involved, were studied.

f) External areas. These are undoubtedly one of the main factors influencing flock density at airports. Their position, population variations, attractiveness for birds -whether due to their being breeding, feeding or rest areas- and their general influence on the airport- positive, distracting birds away from the airport, or negative, favouring their presence- was noted.

4.3.- Results

4.3.1.- Land use

The airports are grouped in regions or geographical types in Table 1.

Land uses causing the greatest problems are pasture and cropland. The former are particularly common in the Cantabria-Galicia area. During the winter, they tend to flood in this region, in contrast to the others. They are highly attractive for waders, which feed on the large number of invertebrates living here. The case of the large numbers of Lapwings and Golden Plovers at Santander Airport is a good example of this problem.

The pastures in the rest of the regions tend to be drier, but also have large numbers of invertebrates. In the Mediterranean area, snails are very common. They seasonally attract seagulls to the edges of the runways.

Croplands are more usual in the drier Mediterranean and Inland areas. They are usually around the perimeter of the airports, but in some cases such as Palma de Mallorca, Barcelona and Sevilla, crops are grown beside the runways. These attract birds during two periods of the annual cycle :

- During the ploughing process, when the soil is broken up by farm machinery, uncovering small prey eaten mainly by gulls, waders and Cattle Egrets.

- When the crop is ripe, provided that it is attractive to birds, as is the case for sunflower and cereals. Small passerines and pigeons are the main species that gather to feed on these crops.

The last two habitats in Table 1 are woodlands and wetlands. The former are not a problem at the majority of airports, however in Mallorca there is a Starling and Thrush roost. The latter areas, which could include the northern pastures, are not necessarily negative. The lagoons at Vigo and Santander Airports area examples of this. In Barcelona, on the contrary, they are the base for a large Starling roost, and a meeting point for herons, ducks, waders and seagulls.

4.3.2.- Potentially dangerous species

Three groups of species are the cause of the majority of bird problems at Spanish airports (Table 2). Waders affect all northern airports,

especially the Lapwing (Vanellus vanellus), the Golden Plover (Pluvalis apricaria), and the Snipe (Gallinago gallinago). These three frequent the wet pastures in search of food, and their populations are subject to changes arising from cold spells in Central Europe.

Lapwings and Golden Plovers are also in the Mediterranean and Inland regions, although in smaller numbers and occasionally accompanied by Stone Curlews (Burhinus oedicnemus), a less frequent resident species. This species is notable in the Canary Islands because there are very few waders which arrive here, even under the effect of cold spells in northern latitudes.

The second group or birds is the seagulls. The wintering species, the Lesser Blackbacked Gull (Larus fuscus) and the Black-headed Gull (L. ridbundus), and the residents, the Herring Gull (Laurus argentatus), are frequent in all the coastal areas and are found at those airports with nearby rubbish dumps, even at inland sites, and those with pasture or cropland. These birds prefer to rest in areas with low vegetation or directly on the runways. This and their habit of continually crossing the airstrips between their feeding and resting places, make them one of the most dangerous species for aircraft.

The third and final group causing general problems at many airports are the Starling (Sturnus vulgaris), and the Spotless Starling (S. unicolor). The former is a wintering species in Spain, which arrives in massive numbers and mixes with the other species, a resident, to form huge flocks. These bird's roosts may house over 100,00 individuals. The airports situated near these roosting places are affected by the movement of the birds at first and last light. This danger is heightened when the roost is within the airport compound, as is the case at Barcelona and Menorca Airports.

Other birds at airports are :

- Pigeons (Columba livia fª domestica) which enter airports from their dovecots nearby in search of food. They may be found at any type of airport because of human influence on their distribution.

- Ducks, especially the Mallard (Anas platyrhychos) frequent wetlands

inside airports, but are especially numerous at Barcelona Airport only.

- The most common Heron is the Cattle Egret (Bubulcus ibis). These are found near some airports such as Sevilla, Malaga and Barcelona.

- Steppeland birds are characteristic of the inland region. Two representative species are the Red-legged Partridge (Alectoris rufa) and the Little Bustard (Otis tetrax). Both are found at Sevilla, the only inland airport with sufficiente data, however they are known to be present at others such as Madrid-Barajas and Granada.

4.3.3.- Flows and resting places

Flows over runways and the presence of resting places depend on the species at the airport, its land use and the external areas. As mentioned previously, waders mostly frequent pastures, while seagulls prefer to rest on runways and areas with little vegetation.

4.3.4.- External areas

Their type and position determine the species that fly over the airports and their flow timing. They thus contribue in determining which species are to be found at each airport. They may be divided into two categories, according to their influence on airports :

Those with a NEGATIVE influence attract massive numbers of birds to airports. These are mainly zones which permit easy and abundant feeding, such as rubbish dumps, fish driers and croplands. The former two, the most influential, may completely modify the range of species at an airport. This was the case at Sevilla airport which, in spite of being inland, was frequented by Lesser Black-backed Gulls and Black-headed Gulls attracted by the Mairena rubbish dump. This is now closed.

In other cases, rubbish dumps affect flows over runways, their timing and intensity. This has been observed at South-Tenerife, Ibiza and Santander Airports.

It is a widespread problem in Spain, as eight of the eleven airports with data on the subject (Table 1) are affected by rubbish dumps.

The second, positive type of external area is that which distracts birds away from airports. They tend to be wetlands where birds are relatively undisturbed and whose water and food resources make them more attractive. The cases that were studied were the Ibiza saltpans, bordering the southern edge of the airport the mouth of the Guadalhorce River, near Malaga airport; and the El Saltadero dam, between South Tenerife airport and the rubbish dump used by the seaguls there.

These types of places ought to be protected under legislation in order to attract larger numbers of birds.

4.4.- General problems at airports according to regions

The results obtained to date confirm the inclusion of the airports in each of the biogeographical regions mentioned. They also permit the prediction of the problems likely to arise if the airport or nearby ecosystem are altered. Thus, for example, further extension of pasture, especially when it is subject to seasonal inundation, will encourage the arrival of larger numbers of waders.

In the Mediterranean area, problems with seagulls are predictable at airports near bird colonies or croplands, or when coastal storms occur. Wetlands within these areas are very dangerous due to the numbers of birds gathering there, especially in the migratory and winter periods (Table 2).

Steppeland birds are common inland, although the expanse of this region and specific factors at each such as crops, dovecots, location, etc, give rise to a greater diversity of problem species here (Table 2).

Seagulls are only a problem in the Canary Islands when rubbish dumps are near airports. The rest of the species observed here are resident and low in numbers (Table 2).

Negative factors affecting airports in every region are rubbish dumps

and dovecots. Both attract large numbers of birds and sometimes radically modify their natural distribution patterns.

5.- SUMMARY AND CONCLUSIONS

The presence of birds at airports may be explained by the following factors :

- The airport position, on a macrogeographic scale, in the context of migratory routes and wintering areas. This gives rise to the classification of Spain's airports into four regions or geographic types -CANTABRIA AND GALICIA; MEDITERRANEAN; INLAND; and CANARY ISLANDS-.

- The main species affecting Spain's airports are those wintering here, closely followed by the residents (Table 2). The most notable groups are seagulls, followed by waders, pigeons and steppeland species. The rest have a more limited, local influence.

- The airport characteristics, especially its physiognomy derived from its land uses. These can encourage the presence or absence of certain species, and determine their numbers. Each airport atrractiveness has been analysed and the land uses alluring the largest number of birds have been determined as pastures, croplands and some wetlands, which ought to be replaced by less attractive landscape such as scrub.

- The final factor is the local environment of the airport. Local land uses and the proximity of rubbish dumps or fish driers affect the presence of gulls and other birds. On the other hand, there are external areas such as wetlands that attract birds away from airports and should therefore be encouraged.

- These studies are a fundamental step towards the reduction of the strike hazard at airports, as they provide indispensable information for the planning of adequate corrective measures. These measures, to be carried out on differing time-scales, include the installation of different loudspeaker systems, the use of detonating cartridges and falconry,

changes in the management of airport ecosystems and the long-term elimination of rubbish dumps and conflictive external areas. For more detailed information, refer to the study "Present State of Strike Hazards at Spanish Airports", presented at this congress.

	PROBLEM / AIRPORTS AEROPUERTO	LAND USES				BIRDS								BIRD MOVEMENTS	RESTING PLACES	ROOSTING PLACES	EXTERNAL AREAS			
		CROPLAND	PASTURES	WOODLAND	WETLANDS	WADERS	GULLS	DOVES	STARLINGS	THRUSTHES	HERONS	DUCKS	STEPPE BIRDS				RUBBISH DUMPS	GULLS COLONIES	FAVORABLE PLACES	FISH DRIERS
CANTABRICO AND GALICIA	Vigo		X			I	I										X(1)	X		
	Bilbao		X			I														
	Santander		X			I	S/I		I					X			X			
	Asturias		X			I	I		I								X(2)			
MEDITERRANEAN	Palma de Mallorca	X	X			I/S	I/S	S	I					X	X		X			
	Ibiza	X	X			I	S							X	X		X	X	X	
	Menorca		X	X			I		I	I					X	X				
	Barcelona	X	X		X	I	I		I		I	S		X	X	X				
	Málaga	X				I	I	S	I		I			X	X		X		X	
INLAND	Sevilla	X	X			I/S	I(2)		I		I		I	X	X		X		X	
CANARY	Tenerife-Sur						S/I	S						X			X		X	X

TABLA 1. Summary of birds problems according to the biogeographical zone, lanz uses, bird species and externd areas

I: WINTER

S: SEDENTARY

(1): PLACED INTO THE AIRPORT TERRITORY

(2): ACTUALLY ELIMINATED PROBLEM

AIRPORTS \ SEASONS	WINTER	SPRING	SUMMER	AUTUMN
Vigo	Larus ridibundus Larus argentatus Gallinago gallinago Vanellus vanellus Corvus corone	Larus argentatus Corvus corone	Larus argentatus Corvus corone	Larus ridibundus Corvus corone
Asturias	Gallinago gallinago Vanellus vanellus Sturnus spp.			Sturnus spp.
Bilbao	Vanellus vanellus Pluvialis apricaria	not studied	not studied	Vanellus vanellus Pluvialis apricaria
Barcelona	Vanellus vanellus Pluvialis apricaria Larus ridibundus Sturnus vulgaris Columba livia fª doméstica	Columba livia fª doméstica Pica pica	Sturnus vulgaris Columba livia fª doméstica	Anas platyrhynchos Vanellus vanellus Pluvialis apricaria Larus ridibundus Sturnus vulgaris Columba livia fª doméstica Pica pica
Palma de Mallorca	Larus argentatus Larus ridibundus Vanellus vanellus Pluvialis apricaria Burhinus oedicnemus Sturnus spp. Gallinago gallinago	Larus argentatus Burhinus oedicnemus	Larus argentatus Burhinus oedicnemus Columba livia fª doméstica	Larus argentatus Larus ridibundus Burhinus oedicnemus

SEASONS / AIRPORTS	WINTER	SPRING	SUMMER	AUTUMN
Ibiza	Vanellus vanellus Pluvialis apricaria	Larus argentatus	Larus argentatus	Vanellus vanellus
Menorca	Larus argentatus Sturnus vulgaris			Larus argentatus Sturnus vulgaris
Málaga	Larus fuscus Larus ridibundus Sturnus spp. Vanellus vanellus	Bubulcus ibis Larus fuscus Larus ridibundus Columba livia fª doméstica	Bubulcus ibis Columba livia fª doméstica	Bubulcus ibis Sturnus spp. Larus fuscus Columba livia fª doméstica
Sevilla	Otis tetrax Pluvialis apricaria Vanellus vanellus Bubulcus ibis	Bubulcus ibis	Otis tetrax Bubulcus ibis Alectoris rufa	Otis tetrax Pluvialis apricaria Vanellus vanellus Bubulcus ibis
Tenerife	Larus argentatus Larus fuscus	Larus argentatus Columba livia fª doméstica	Larus argentatus	Larus argentatus

TABLE 2.- Main seasonal problems of different bird species at the studied spanish airports

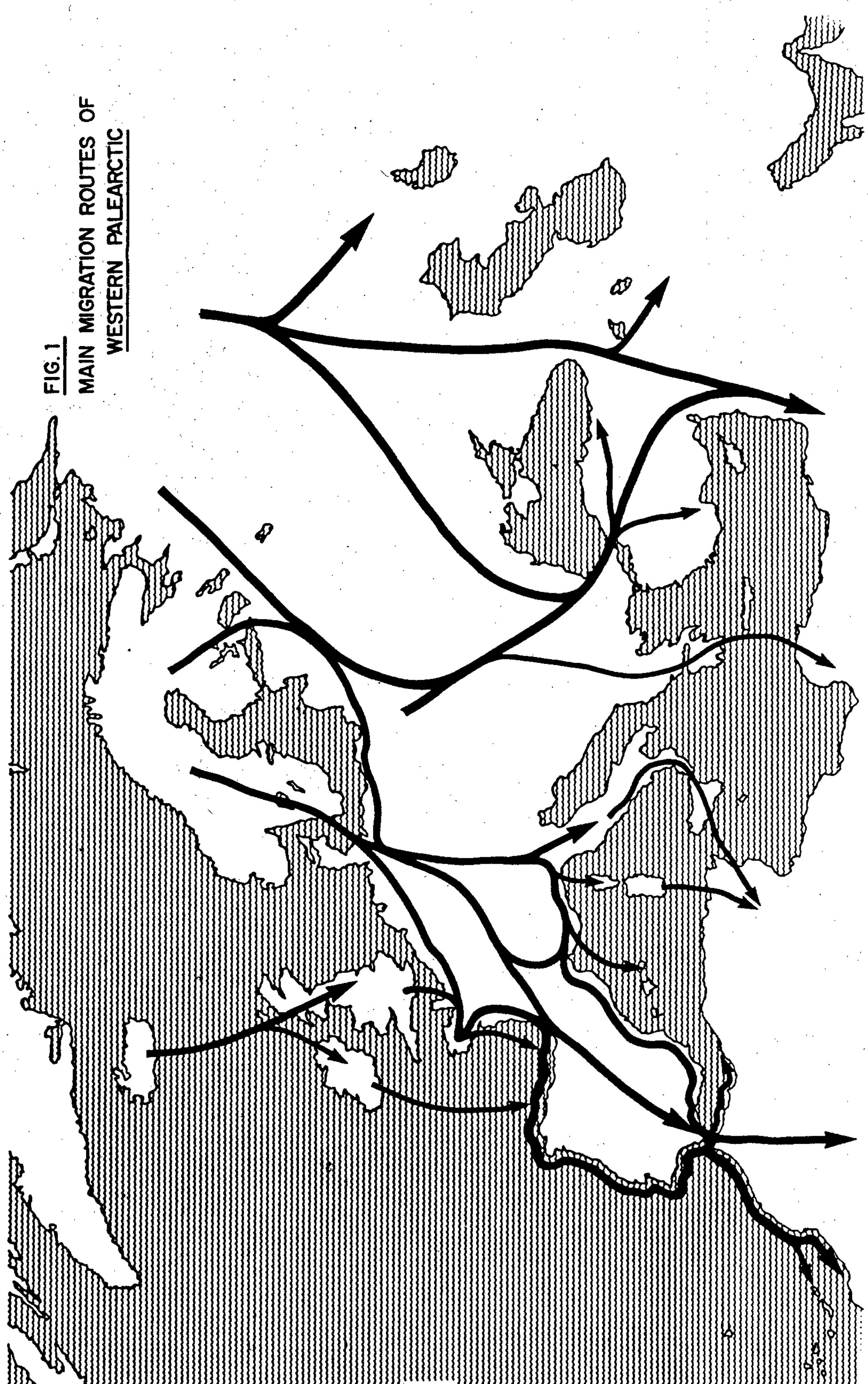


FIG. 1
MAIN MIGRATION ROUTES OF
WESTERN PALEARCTIC

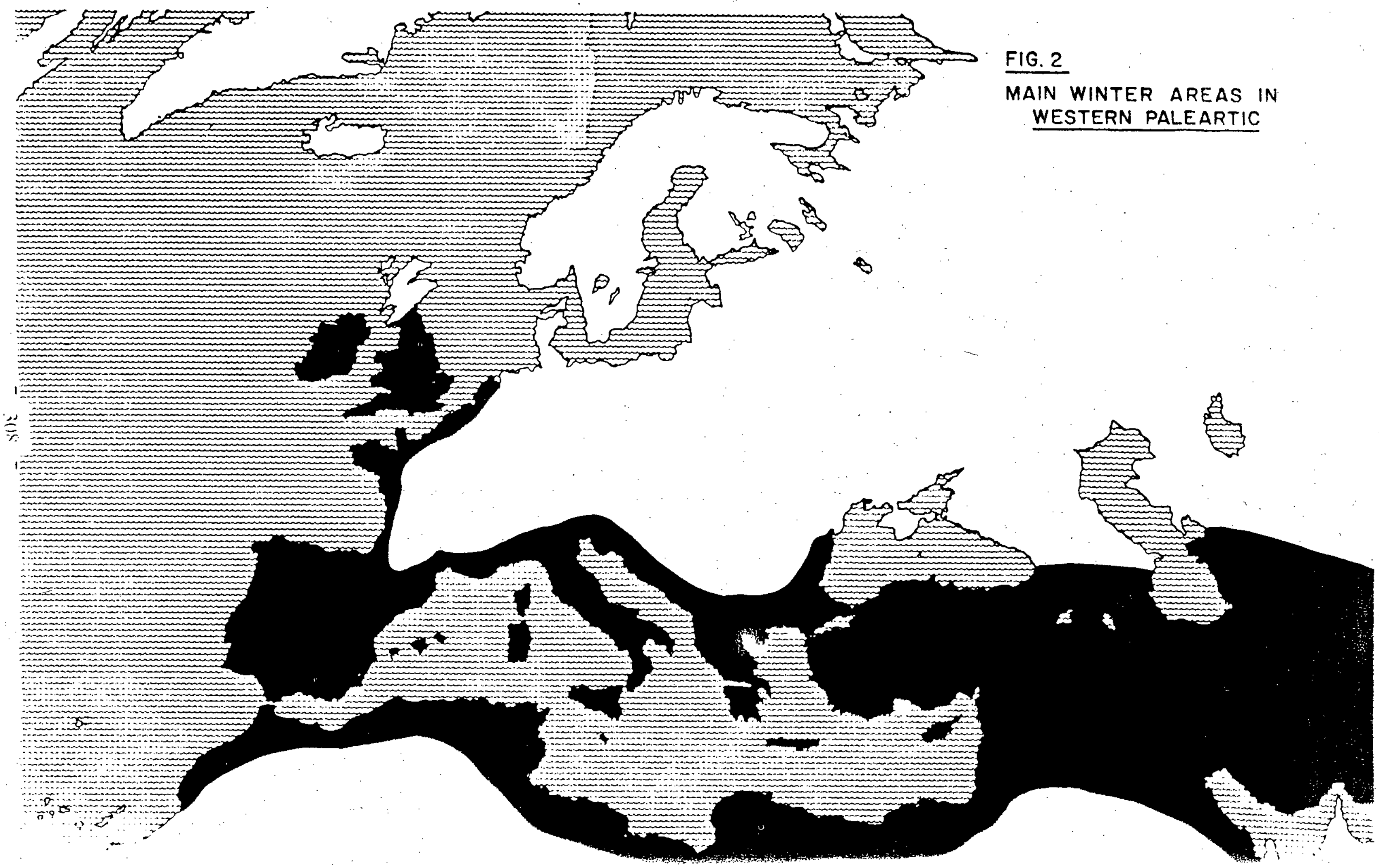


FIG. 2

MAIN WINTER AREAS IN WESTERN PALEARTIC

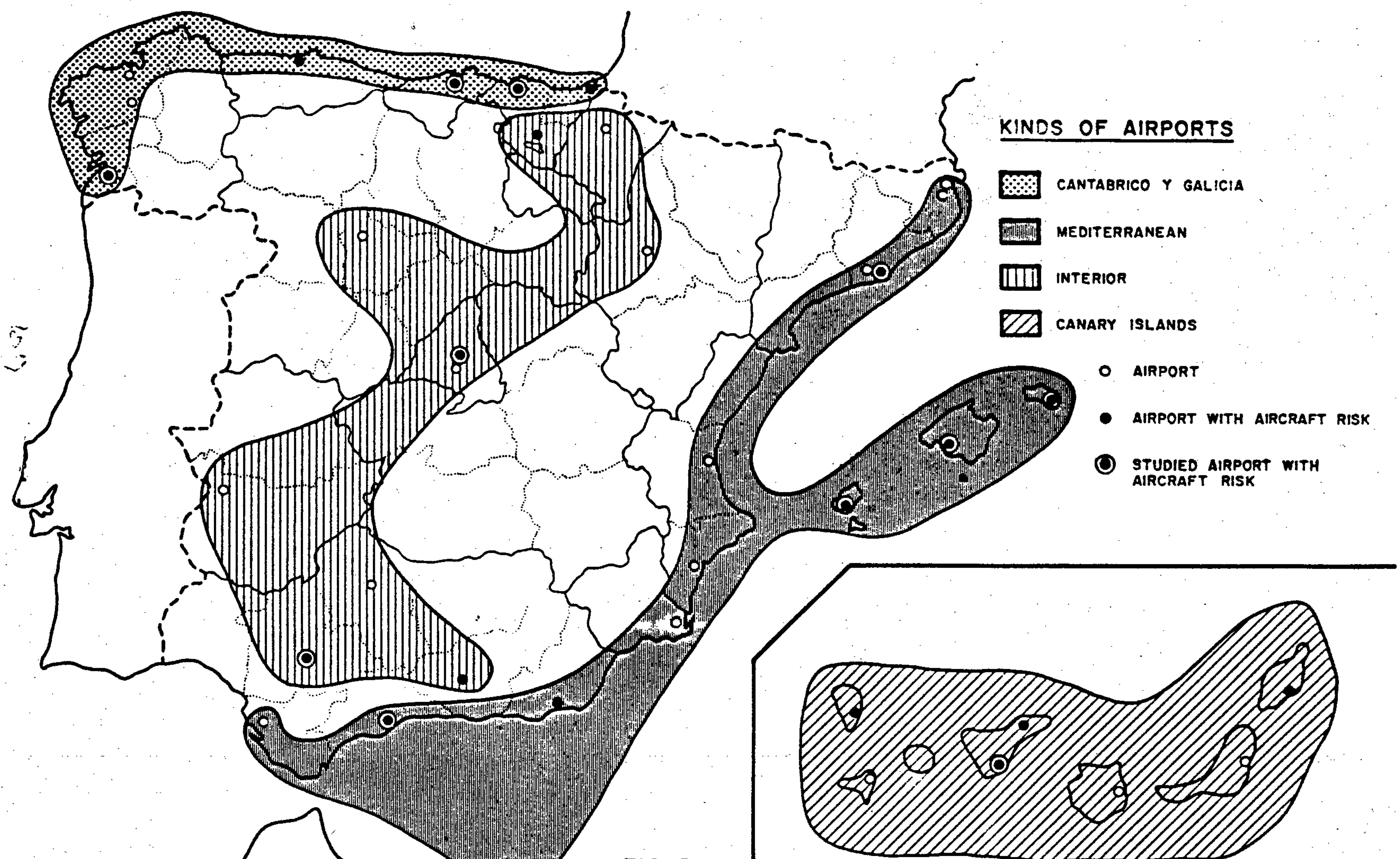


FIG. 3
SPANISH AIRPORTS DISTRIBUTION

ADF616018

Present state of bird strike hazards at Spanish Airports. Index

(Juan Ruiz, Spain)

BSCE 19/ WP 21

Madrid, 23-28 May 1988

PRESENT STATE OF BIRD STRIKE HAZARDS AT SPANISH AIRPORTS

INDEX

ABSTRACT

The present state of strike hazards at Spanish airports is analyzed, focussing on the follow aspects : (1) administrative organization, (ii) the gathering of information, (iii) measures adopted on different time and (iv) future trends.

All aspects of strike hazards are dealt with by the Laboratory Services of the Spanish Airports Authority, working closely with the 38 airports and military bases open to civil air traffic. Their information sources are OACI questionnaires, maintenance technician's reports and general data from airport staff. The work of the Laboratory Services is aimed at increasing airport staff awareness of the problem.

The measures aimed reducing strike hazards are separated into three phases: (i) emergency measures, including falconry, detonating cartridges, gas explosions and acoustic alarm signals, (ii) short and medium-term measures aimed at substitutory or optimizing previous emergency measures and finally (iii) long-term measures to be taken in the future are analyzed, distinguishing those to be carried out within airport compounds from those in external areas.

INTRODUCTION

The subject of problems arising from bird strike hazards has been covered extensively. Spanish airports are not at all immune to the problem. The unique characteristics of Spain's landscape have give rise to one of Europe's richest and densest bird nesting grounds, to which a large flow of wintering and migrating birds must be added. This is evidently reflected in the number of birds that cause problems at airports. Measures have been taken to (i) foresee these risks and (ii) reduce them as much as possible.

The work at airports in the Spanish State aimed at reducing strike hazards is coordinated by the Spanish Airports Authority. Its role is to (i) analyse the information received from the different airports and airline companies, (ii) carry out the necessary studies to evaluate the problem correctly, and (iii) specify the necessary measures to reduce the risk, both in planning airport land

use and in installing and operating bird scaring equipment.

This work began with a series of urgency hazard reduction measures, including falconry and loudspeaker systems. These provisional methods are being revised in two ways. Firstly, via formal studies on bird populations causing risks at the most seriosuly affected airports, and secondly, via the improvement and optimal usage of available equipment.

To date of 19 airports with bird problems, 11 have been subject to studies lasting at least one year; 3 others of a similar nature are planned for 1988-89; while the remaining 5 have not commissioned any studies as yet given the lower level of presence and danger of their bird populations.

The present study analyses (i) the structure and function of the bodies responsible for the fight against bird problems at Spanish airports, (ii) the eradication methods used in the past and the present, (iii) the main results obtained from the studies already carried out, and (iv) the short, medium and long-term corrective measures considered necessary.

2.- LABORATORY SERVICES OF THE SPANISH AIRPORTS AUTHORITY

In the administrative organization in the Spanish State, all responsabilities relates to the use and management of any mode of transport are covered by the Ministry of Transport, Tourism and Communication. The airports have an Autonomous Body at the General Management level on the State administrative scale. This body, entitled the Spanish Aiports Authority, includes a Technical Subdirector-general in charge of the LABORATORY SERVICES (L.S.) (Fig. 1).

Among the responsibilities and activities of the Laboratory Services are : (i) the evaluation of airfields with respect to the state of their surface and pavement strength, (ii) the analysis of lighting, electrical equipment, etc., and (iii) the evaluation and control of noise, atmospheric pollution, and in general any disruption of the environment in and around airports.

This last group of activities are divided into two units composed of different teams of specialists. One, the Acoustics and Vibrations Unit responsible for disruptions produced by aircraft noise, and acoustic equipment at air terminals. The other, the Pollution and Ecosystems Unit, is responsible for the prediction and measurement of atmospheric pollution, water treatment and analysis, the preparation of guidelines for the definition of airport ecosystem uses, the study and observation of bird populations and means of reducing strike hazards. It is important to stress that the Laboratory Services work closely with the 38 airports and military bases that are open to civilian air traffic in Spain, either through the Technical Subdirector-general or with each one directly.

3.- THE STUDY OF STRIKE HAZARDS

It was decided that the L.S. should coordinate decisions related to bird collisions at airports in order to make better use of its experience and information. This information comes from three sources :

- The OACI questionnaires. These should be filled out by pilots each time an incident occurs, whether or not there is a collision. They should then be submitted to the L.S. for analysis and to permit a wider knowledge of the potential danger.

  In reality, very few pilots comply with this reccomendation, and only return the questionaires when material damage or a serious in-flight incident occurs. These files used to be sent to the Civil Aviation General Management where a commission analysed all the circumstances and responsibilities derived from any accident. Until very recently, the reports were dealt with and filed away here, but recently a dialogue and information exchange has begun between this body and the L.S.

- Reports by Maintenance Technicians. If bird remains are found during motor revision, the airline must be informed of the damage. These reports are occasionally passed on to the relevant section of the L.S. Their common denominator is a lack of data on the species responsibles for the damage.

- Information collected at airports. Either air traffic controllers or other airport staff such as firemen note the details of any incident observed and pass them on to the L.S. This source has the advantage of being the only one taking a direct route to those responsible for bird studies. It is also, however the source which includes the least detail on each incident.

  In 1987 a coordinator was appointed at each airport for the study and eradication of its bird problem.

  The main role of the L.S. is therefore the improvement of the data collection process by increasing staff awareness.

4.- PROGRESS OF BIRD STUDIES AND STRIKE HAZARD REDUCTION MEASURES

The overall process may be divided into the following phases :

- Initial awareness of the existence of the problem
- Emergency corrective measures
- Studies on bird populations at airports, slightly out of step chronologically with the former phase.
- Having obtained the results from these studies, some of the emergency measures have been rejected, while others have been seen to be thoroughly reccommendable, with slight modifications in some cases. It has been possible to plan short, medium and long-term measures in order to minimize the effect of the problem.

5.- INITIAL EMERGENCY CORRECTIVE MEASURES

The main emergency measures taken were :

- Falconry. One of the first methods used. Based on the hunting ability of Falcons and other birds of prey, and the aversion of certain species of birds to their mere presence.

  Their use has proved particulary effective in the control of steppeland

birds such as the Little Bustard and some waders such as the Stone Curlew, and the Golden Plover. Satisfactory results, however, are only obtained when expert handlers are employed. It should also be stressed that the falcons used should be limited to individuals guaranteed to be birds raised in captivity.

To date, this technique has been used at three civilian airports (Table 1) and two Spanish military bases. Results show it to be a generally effective method. Its continued use in the future is foreseen.

- Shotgun hunting. This may have been the first method used in chronological order, however positive results were never obtained. At present, the Spanish Hunting Law prohibits the use of firearms around inhabited areas, including airports. Its use may only be considered as a localized, restricted measure, in combination with other techniques. The state of conservation of the target species must also be considered.

- Gas cannon detonations. This equipment is in use at three Spanish airports (Table 1). It is highly effective initially after its installation, but becomes less so with time as the birds become accustomed to the noise.

  To avoid this loss of efficiency, the detonators may be set to explode at random. This does imply, however, a risk to staff crossing the runways due to the unpredictable and dangerous streams of hot air emanating from the cannon.

- Loudspeaker systems with alarm signals. The first equipment used at Spanish airports was portable and was installed on vehicles which moved to the sites where birds gathered. Use and experience with this equipment at nine ariports (Table 1) suggests that maximum effectiveness is obtained by minimizing problems derived from :

  - Low acoustic quality of recordings. This may seriously detract from the transmitted message.

  - Scarcity of recordings of different species. The airport studies are

helping to overcome this problem by specifying the most numerous species.

Birds becoming accustomed to the recordings. This is notable, but may be avoided by restrincting the use of the equipment, increasing the duration of the recordings, and changing them periodically.

The installation of new equipment has continued now that technical problems such as energy sources, currently solar panels, have been solved. The equipment is now fixed (Table 1) and sends out two types of signals :

- Alarm cries, ideal for immediate action on birds, bearing the previous reservations in mind.

- Electronic noise, which irritates birds due to its frequency and aids longer-term eradication plans.

6.- BIRD POPULATION STUDIES

Both the planning of corrective measures to avoid bird collisions and the evaluation of the results, ought to be preceded by in depth studies on bird communities in airport compounds. This step was begun by the Laboratory Services of the Spanish Airports Authority after the first emergency measures were adopted.

As a first step, the 38 airports and military bases were catalogued according to the types of complaints received from pilots, maintenance staff and airport managers. In all, 19 were considered to have some type of problem, and these were classified according to their type of risk. In order to decide which airports should receive preferential treatment in the analysis of their problems, the level of danger at each one was considered alongside the desire for an overall view of the problems affecting each biogographical region, composed of 7 airports in the Cantabria-Galicia region, 14 airports in the Mediterranean region, including Melilla and the Baleares Islands, 7 airports in the Canary Islands region, and 10 airports in the Inland region.

This initial classification, based on purely biogeographical data, has since been confirmed in the analysis of the study results. It permits the prediction of the overall problems at the airports that were not analysed.

To date, 10 airports have been studied, another is currently underway and 3 are planned for 1988 and 1989 (Table 1). The 5 remaining airports are not considered to have particulary serious problems and at present their analysis is not planned.

The results obtained from the studies are set out in a general form below.

a) Species

The main species affecting air traffic at Spanish airports have been identified, along with their phenology, preferred habitats and behaviour at airports. The may be divided into the following groups:

- Wintering species, the largest group. They arrive in massive numbers when a cold spell hits Central Europe. Those which stand out are the Black-headed Gull (**Larus ridibundus**), the Black-backed Gull (**L. fuscus**), the Lapwing (**Vanellus vanellus**), the Golden Plover (**Pluvalis apricaria**), and the Starling (**Sturnus vulgaris**).

- Resident species, including many types of birds, some of which receive new contingents from Europe in winter. They include the Herring Gull (**L. argentatus**), the Stone Curlew (**Burhinus oedicnemus**), the Little Bustard (**Otis tetrax**), the Red-legged Partridge (**Alectoris rufa**), the Cattle Egret (**Bubulcus ibis**), and the Mallard (**Anas platyrhinchos**). The Domestic Pigeon (**Columba livia fª domestica**) is an individual species belonging to this group although its distribution is affected by its dependence on man.

b) Airport ecosystems

Birds are attracted to airports for varying reasons, and the understanding

of these aids bird eradictaion measures. Observations have shown that pasture and croplands within airport compounds are two main gathering points. Birds do not tend to gather in dangerous numbers in scrubland, however. Wetlands and woodlands are overrun at times by large numbers of dangerous birds, such as the cases of Starling roosts in Barcelona and Menorca, while in other cases their influence is minimal, as in the case of the lagoon at Santander Airport.

c) <u>External areas</u>

Some external areas directly affect the presence, flows, timing and behaviour of birds within airport compounds. Some nearby wetlands, for example, distract birds away from airports and may thus be considered to have a positive influence. Areas with a negative influence encourage the presence of birds by offering them feeding zones such as rubbish dumps and fish driers, from where many birds fly to a nearby airport to rest. Efforts will be made to eliminate or move these negative areas away in order to reduce the strike hazard.

d) <u>Periods or Seasons</u>

As mentioned above, the majority of the birds at our airports are wintering species. The strike hazard is thus highest during these months. At some airports large flocks of gulls are also seen in summer, as with the Herring Gull at Ibiza Airport. This occurs after the reproduction period in cases where the airport is near a breeding ground. Other airports suffer from being on the path of one of the main migratory routes that cross Spain in autumn and spring.

7.- SHORT-TERM CORRECTIVE MEASURES

These include some emergency measures already in use, such as falconry, which have proven to be effective. Other techniques will be extended to improve their effectiveness, as with new loudspeaker equipment. Their installation will assure maximum effectiveness when added to the equipment already in use using the precise information now available on bird gathering

points.

It is expected to coordinate the use of alarm cries from control towers. When planning action with this equipment, especially when using electronic noise, longer-term effectiveness ought to be born in mind.

Detonating cartridge launchers are another technique used for immediate effect in special situations, they have been supplied to the 19 problem airports (Table 1) for use in order to scatter flocks resting on runways or to detour bird flows away from them. Continual use may influence the routes of some species and force them to leave the airport, when used in combination with other techiques such as falconry, electronic noise etc.

8.- MEDIUM-TERM CORRECTIVE MEASURES

The main activity, already begun at some airports, is the modification of their ecosystems. Those posing the greatest danger are :

Crops. The first steps are the substitution of attractive plants, cereals, sunflowers, etc, with others that do not attract so many birds such as cotton or tobacco. Work on the soil should be carried out at night to permit the uncovered invertebrates to hide before the arrival of birds.

Pastures. Worms and snails here attract large numbers of waders and gulls. When the grass is cropped, pastures are used as resting places, while grass more than 20 cm tall is used by rodents which in turn attract certain birds of prey. This latter problem is not as serious as the former, but pastures should be substituted in any case by scrub.

Wetlands. These ought to be restricted or eliminated when their influence is seen to be negative. At Barcelona Airport, for example the duck and starling problem would be solved by this measure, while it would have no effect on safety at Santander Airport.

These land uses affect airports differently in each of the four regions. Flood-prone pastures are quite common in the Galicia-Cantabria region,

and many waders are thus present. Pastures, with waders and gulls, and croplands, are common at Mediterranean airports, while the latter landscapes are the most common inland. Sufficient data is not availabe as yet on the influence of airport ecosystems in the Canary Islands given that the problems noted to date have all been due to external areas.

9.- FORESEEN LONG-TERM MEASURES

This section includes direct action on troublesome external areas detected in the studies, as well as planning measures for the use of eradication equipment.

The main problems that must be dealt with urgency are :

a) The heavy pressure of hunters on areas around airports. These zones should be restricted to encourage birds to roost further away from airport boundaries.

b) Rubbish dumps and other feeding points. This subject has been dealt with by several writers. The aim is to avoid birds gathering at one site near an airport, or to avoid their having to fly over any runways in order to reach their feeding ground. There should be areas near rubbish dumps that are attractive as resting points and thus distract the birds' attention away from airports altogether.

   Other food sources such as fish driers and crops should be dealt with in the same way. Evidently the latter problem cannot be eliminated, but the type of crop and the timing of farm work may be altered.

c) Dovecots have also been frequently mentioned in studies on strike hazards. Domestic Pigeons move from their dovecots to wastelands, crops and pastures at airports in search of food and thus become a nuisance. The solution is simple, but often difficult : all such instalations should be eliminated.

d) Along with the elimination of hunting pressure, measure a), external areas should be promoted which, due to their location and type, are capable of absorbing bird populations currently within airport compounds. The majority of species affecting Spanish airports have aquatic habits. Wetlands must therefore be encouraged or created specifically for the purpose, and those with any importance must be protected. These measures should be the result of collaboration between several branches of the Spanish government. A certain amount of time will thus be neccesary for the first results to appear.

e) The last and perhaps the most controversial measure from a conservation point of view is the direct population control of some of the most dangerous species. To a large degree, the negative influence of man has led many species to prosper in recent years to the point where they pose a problem for other species and many human interests. The best-known cases are seagulls, the Herring Gull and the Black-headed Gull in this case, which have an extremely negative influence on airports and prey on or displace other birds from their breeding grounds.

10.- CONCLUSIONS AND SUMMARY

It is undoubtedly necessary to define the problems clearly, analyse their causes and propose practical solutions. These three stages have been or are being covered by the Spanish Airports Authority and its Laboratory Services, in order to eliminate the strike hazard at each of Spain's airports.

a) Understanding of the problems is improving due to the collaboration of other bodies involved in data collection. Greater awareness on the part of pilots, ground staff and airport management will encourage their participation in this project and increase the flow of information to the Laboratory Services.

b) The problem source analysis is at an advanced stage as the study of the majority of airports with bird problems is almost complete. These studies should be revised periodically to permit a close watch on the evolution of bird populations at each airport and the effects of eradication measures

put into practice. There must be specialized staff at each airport, or at least at those with bird problems, whose job it is to collect data, analyze it and pass it on to the Pollution and Ecosystems Unit of the Laboratory Services. This phase has already begun with the designation of a staff member at each airport who is responsible for bird problems.

c) Solutions are to be applied in three phases, short, medium and long-term, in accordance with their location :

Measures to be taken within airport compounds

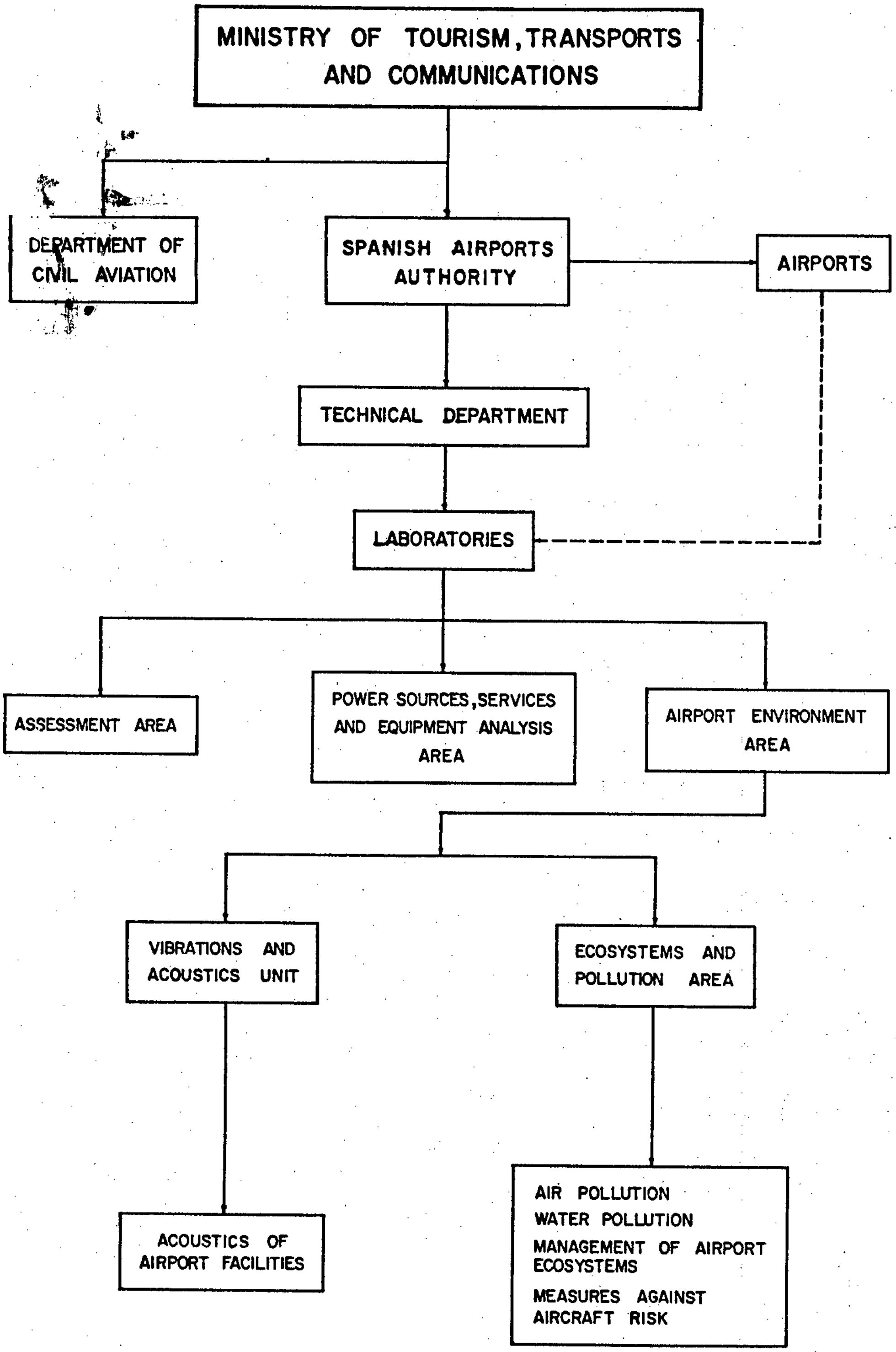
1) Falconry (short term)
2) Loudspeaker systems with alarm cries and electronic noise (short-term)
3) Modification of airport ecosystems, especially crops, pastures and some wetlands (medium-term).
4) Direct pressure on flocks and birds flows to push them away from airports (short and medium-term).

Long-term measures to be taken outside airport compounds

1) Supression of hunting pressure
2) Elimination of rubish dumps and other large sources of food for birds.
3) Elimination of dovecots
4) Protection or creation of external areas, preferrably wetlands, that serve as bird refuges.
5) Population control of some particularly abundant and dangerous species.

All of these measures will be coordinated by a member of each airport's staff who will evaluate the results and propose further solutions according to the specific situations observed.

FIG. 1


MINISTRY OF TOURISM, TRANSPORTS AND COMMUNICATIONS
DEPARTMENT OF CIVIL AVIATION
SPANISH AIRPORTS AUTHORITY
AIRPORTS
TECHNICAL DEPARTMENT
LABORATORIES
ASSESSMENT AREA
POWER SOURCES, SERVICES AND EQUIPMENT ANALYSIS AREA
AIRPORT ENVIRONMENT AREA
VIBRATIONS AND ACOUSTICS UNIT
ECOSYSTEMS AND POLLUTION AREA
ACOUSTICS OF AIRPORT FACILITIES
AIR POLLUTION
WATER POLLUTION
MANAGEMENT OF AIRPORT ECOSYSTEMS
MEASURES AGAINST AIRCRAFT RISK

MITIGATION MEASURES (EQUIPEMENT QUANTITY) / AIRPORTS WITH PROBLEMS	FALCONRY	GAS CANNON DETONATIONS	PORTABLE LOUDSPEAKERS (ALARM CRIES)	FIXED LOUDSPEAKERS (ALARM CRIES)	FIXED LOUDSPEAKERS (ELECTRONIC NOISE)	DETONATING CARTRIDGES	BIRD STUDIES
VIGO		1	1			2	X
ASTURIAS						1	X(1)
SANTANDER			1			1	X
BILBAO						1	X
SAN SEBASTIAN						2	X(1)
VITORIA						2	X(1)
MADRID-BARAJAS	X					1	X(1)
SEVILLA	X		1			2	X
GRANADA	X		1			1	
BARCELONA		4	2	8	16	2	X
MENORCA		1	1		8	1	X
PALMA DE MALLORCA			2	8	16	2	X
IBIZA			1	4	4	1	X
ALMERIA						1	
MALAGA			1			1	X
LANZAROTE						1	
LA PALMA						1	
TENERIFE-NORTE						2	
TENERIFE-SUR				3	8	1	

(1) In progress or planned

TABLE 1. BIRD ERADICATION MEASURES AT SPANISH AIRPORTS

ADF616019

Serious birdstrikes to civil aircraft 1985 to 1987

(John Thorpe, UK)

SERIOUS BIRDSTRIKES TO CIVIL AIRCRAFT 1985 TO 1987

John Thorpe - UK Civil Aviation Authority
Safety Data & Analysis Unit

SUMMARY

The Paper contains a sample of detailed histories of accidents and more serious incidents (e.g. double engine ingestion, holed airframe, fire, uncontained engine failure) for the years 1985 to 1987. The Paper is divided into three groups:

- Transport Aircraft over 5,700 Kg and Executive Jets

- Aeroplanes of 5,700 Kg and below

- Helicopters

No attempt has been made to analysis the information although it is apparent that for transport aircraft as before, the critical area is engines (27 out of 46 incidents in the paper) and for light aircraft and helicopters the windshield may be the critical area. As far as is known during this period there have not been any hull losses.

The author would welcome any new or additional information as the paper relies heavily on UK and ICAO information.

SERIOUS BIRDSTRIKE TO CIVIL AIRCRAFT 1985/86/87

AEROPLANES OVER 5700KG AND EXECUTIVE JETS

Date	Aircraft	Regn	Operator	Location	Total Aboard	Injury
11.01.85	B737(JT8D)	G-BGDO	British Airways	Aberdeen, UK	120	Nil
	During the approach at about 200 ft and 130 knots the aircraft passed through a flock of Lapwings (Vanellus vanellus) it rose from fields near the airport. Both engines, radome, windscreen, wings and fuselage were struck. 4 fan blades were shingled in engine 1 and 1 fan blade shingled in engine 2.					
17.02.85	A300B(CF6)	F-BUAM	-	En-route in France	-	-
	At 2300 ft and 240 knots a Greylag goose (Anser anser, 3.3 Kg) was ingested by No 1 engine. There was fire and the engine was shut down and the aircraft re-routed to Toulouse. 21 blades were damaged and the aircraft was out of service for 53 hours.					
18.02.85	DC8-70(CFM56)	CF-TIS	Air Canada	Brussels	-	-
	At 145 knots during take off, birds (gulls) were ingested in engines 3 and 4 and the take off was abandoned. One tyre blew.					
16.04.85	DC3	G-AMCA	Air Atlantique	Nr Luton, UK	-	-
	At about 1000 ft and 120 knots during the approach, birds struck the windshield causing a crack in both the inner and outer panes.					
16.04.85	B737	-	Far Eastern Transport	Taipei, Taiwan	93	Nil
	The aircraft skidded off the runway during take off after a bird struck the right hand engine.					
27.05.85	DC9(JT8D)	CF-TMX	-	Toronto	-	-
	One blade on each of No 1 and No 2 engines was found to be damaged.					
30.06.85	B727	D-ABKE	Lufthansa	Boukhalf, Morocco	-	-
	During the take off run 100+ pigeons were struck. The auxiliary and No 2 pitots were blocked by bird remains and the pilots airspeed and mach indicator became unserviceable. Fuel was jettisoned and the aircraft returned for a precautionary landing. The landing lights were found to have been destroyed.					
06.07.85	BAE146	N-	-	Nr Los Angeles, USA	-	-
	Whilst climbing through 7000 ft at 250 knots a flock of gulls broke the right A windshield.					
14.07.85	B747(JT9D)	-	-	Heathrow, UK	-	-
	At about 100 ft and 180 knots in the climb a flock of pigeons were ingested in engines 1 and 2 resulting in blade, spinner and nose cowl damage.					
28.07.85	B747(CF6)	N-4548M	KLM	Amsterdam, Netherlands	-	-
	At 130 knots during the take off run a flock of pigeons were struck resulting in the take off being abandoned. First row of fan blades were badly damaged, the N1 sensor was struck by a large piece of fan blade which exited through the fan cowl causing a large hole. The tail cone was torn off and the abradable seal was gone. Trailing edge flaps were damaged by pieces of blade.					
29.07.85	B747 (RB211)	-	Air New Zealand	Christchurch, New Zealand	370	Nil
	At flotation on take off birds were ingested in three engines. Two were shut down shortly afterwards, the aircraft climbed on three engines before a second engine was throttled back. Fuel was jettisoned prior to landing. Two engines were removed, one having fan blade and duct damage. The birds were oyster catchers (Haematopus ostralegus weight 500 gm).					
31.07.85	B727	N856		Green State, USA	-	-
	During the landing roll at 125 knots a flock of birds punctured the wing leading edge. Three dead birds were found inside the wing and the wing tip was also damaged.					

13.08.85	B747SP(JT9D)	HL-7457	Korean Airlines	Kimpo, Korea	-	-

Take off was abandoned at 130 knots after a flock of birds were ingested in engines 2 and 3. 2 fan blades were replaced on engine 2 and 3 fan blades in engine 3.

18.08.85	DHC6	-	-	New London, USA	-	-

A Canada Goose bent one propeller after it was struck during the landing roll at about 65 knots.

28.08.85	B727	-	-	Green State, USA		

At 120 knots during the take off run a Canada goose (Branta canadensis, 3.6Kg) struck the wing leading edge breaking two slats. Take off was abandoned, resulting in blown tyres.

02.09.85	B737(JT8D)	C-GOBD	-	Baie-Comeau, Canada	-	

At about 50 ft and 140 knots, a flock of gulls was struck damaging the left stabiliser and wing leading edge. Engine 2 was also struck and the airframe was holed. 23 birds struck the aircraft. An immediate return was made.

13.09.85	B747	-	-	Grant County Airport, USA	-	-

A flock of birds damaged engines 1 and 2.

24.09.85	Fokker F28	-	-	Durham, USA	-	-

Whilst approaching the airport at about 2000 ft a flock of birds damaged the radome, antennae and pressure bulkhead.

01.11.85	Fokker F27	VT-DMV	-	Lilabari, India	-	-

At 1500 ft during the approach at a speed of about 170 knots, a large vulture was struck which damaged the right wing outboard of the landing light causing a heavy fuel leak.

15.11.85	DHC6	-	-	Nr Republic, USA	-	-

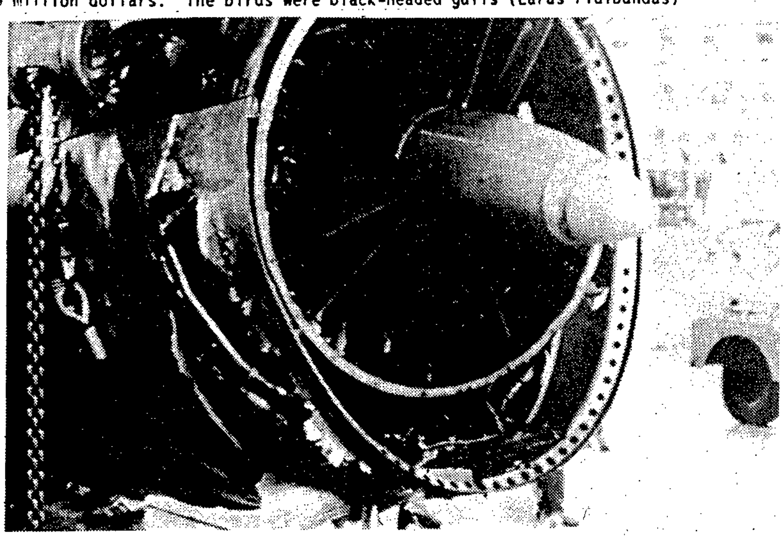
During the climb at about 170 knots a flock of geese left a large gaping hole in the outboard left wing.

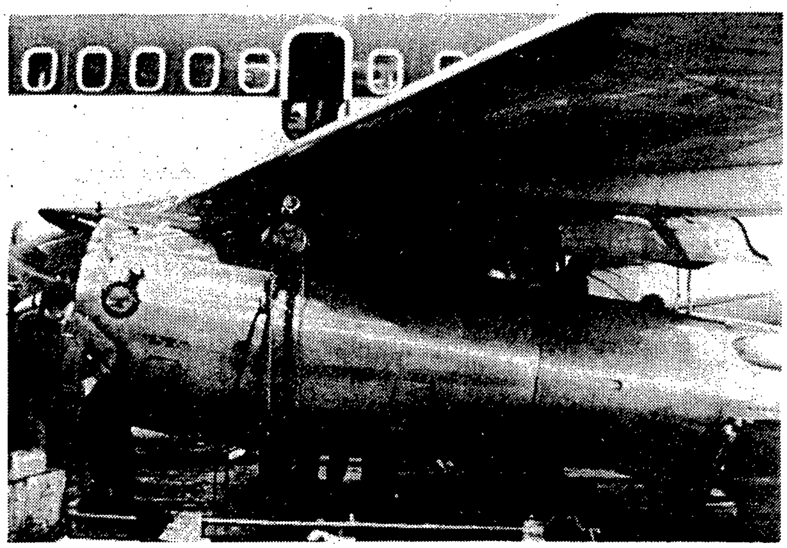
01.12.85	L1011	-	-	Lambert - St Louis, USA	-	-

During the take off run a flock of birds damaged the left landing light shattering the lense and bucket pushing it back into a hydraulic line causing failure of the line and system A. There was heavy nose cowl damage to engine 3.

07.12.85	B737(JT8D)	EI-ASA	Aer Lingus	Dublin, Ireland	-	Nil

At 50 ft after take off a flock of gulls were struck. No 1 engine surged and throttle lever slammed rearward by itself passing the detent and unlocked the thrust reverser. The engine was shut down and a single engined landing was made. No 1 engine nose cowl was missing, 8 first stage fan blades were liberated and the inlet case and both front and rear fan containment cases had major penetrations. 2 of the 3 engine mount bolts were fractured and the engine was attached by the front left cone bolt and flexible hydraulic lines at the rear of the engine. Bird remains were found in the fan discharge duct, left hand main gear well and outboard trailing edge flaps of the right hand wing. Engine 2 had some damage from parts which may have bounced off the runway, and the leading edge of the horizontal stabiliser was changed as well as the radome. A cockpit side window outer pane was also damaged. A total cost was approximately 1.5 million dollars. The birds were black-headed gulls (Larus ridibundus)





21.12.85 B727 F-BPJP Air Italia Milan Linati, Italy - -

At 30 ft during the approach engines 2 and 3 ingested Black headed gulls. Boroscope inspection necessitated changing a compressor blade on engine 3.

30.12.85 B737 ZS-SBO SAA East London, South Africa - Nil

The aircraft returned after a blue crane (Anthrapoidese paradisea weight 3.5 Kg) was ingested in Engine 1. The majority of fan blades were broken or liberated and several bolts were broken at B flange. Oil tank was detached from its mount.

01.01.86 Boeing 737(JT8D) EI-BEC Aer Lingus Dublin, Ireland - -

At 130 knots during the take-off run a flock of lapwings was ingested in Engine 2. The take off was abandoned and the aircraft stopped 200 metres from the end of the runway. Some damage was found to Engine 2.

12.02.86 Boeing 707 - - Nairobi, Kenya - -

At 300 feet after take-off an engine ingested a bird. The engine caught fire. The aircraft returned and ground personnel extinguished the fire.

07.03.86 Boeing 737 C-GNDW - Toronto, Canada - -

Collision at 2500 and feet and 240 knots with birds of unknown species smashed a landing light, bent a frame, skin and internal wing structure, and cracked No 3 leading edge flap.

07.04.86 Boeing 747(RB211) G-BDXH British Airways En route in Middle East -

A collision with cuckoos (Cuculus 100gm) damaged the radome and front pressure bulkhead. Intermittent picture on both radar systems during descent and approach.

07.04.86 Boeing 747(CF6) PH-BUN KLM Amsterdam, Netherlands -

During the climb at about 800 feet a high power stall occurred on Engine 3. Fuel was jettisoned and the aircraft returned. The fan was found to be heavily damaged; the nose cowl, fan reversers and fan doors were also damaged and the exhaust cone missing. Bird species unknown.

10.04.86 Boeing 737(JT8D) VT-EFL - Raipur, India - -

At about 2800 feet and 245 knots during the approach a vulture struck the wing leading edge causing a 35cm x 35cm hole between the wing root and the right engine. The trailing edge flap was slightly damaged.

30.04.86 Boeing 737(JT8D) VT-EAG - Delhi, India - -

At 800 feet and 150 knots on the approach the windshield on the captain's side was shattered after striking a bird of unknown species.

02.05.86 Fairchild 227 N- - Rapid City, US - -

During the approach at 180 knots a flock of eagles caused extensive damage to leading edge of the right wing between the fuselage and engine and to the leading edge of the right horizontal stabilizer.

22.05.86 Boeing 747(JT9D) N- - JFK, New York - -

During the approach birds damaged Engines 2 and 3. An engine or engines were shut down.

28.05.86 Boeing 737(JT8D) AP-BCB - Chaklala, Pakistan - -

The ILS glideslope antenna mount was damaged, radar hinge bracket bolts sheared, small hole in the fuselage skin and honeycomb structure of radome separated after striking birds on the approach.

15.06.86 A300B(CF6) VT-EFW - Bombay, India - -

Pigeons were ingested in both engines, resulting in fan blade damage to both engines. A precautionary landing was made.

10.07.86 A300B(CF6) F-BUAK Air Inter Nice, France - -

At 130 knots during the take-off run a flock of Herring gulls (Larus argentatus) was struck resulting in a precautionary landing. In Engine 1 seven fan blades required replacement and in Engine 2 two fan blades required replacement. There was damage to the wing leading edge.

20.07.86 B737 C-GQBH Quebec Air Warbush, Newfoundland 63 -

The aircraft was substantially damaged when it over ran the runway on take-off. Some passemgers sustained slight injuries during the emergency evacuation. It is understood that during the take-off run the aircraft encountered a flock of birds which were ingested into the left hand engine. The abandoned take-off was on a runway described as slippery following heavy rain resulting in the over-run into soft ground.

14.09.86 Boeing 747(JT9D) CF-TOE Air Canada Tessera, Italy - -

Birds of unknown species were ingested in Engines 3 and 4 at about 50 feet during the climb. Fuel was jettisoned and a precautionary landing made. Seven birds were struck. The aircraft returned to service.

22.10.86 Boeing 720(JT3D) 9H-AAO Air Malta Luqa, Malta - -

At about 50 feet and 145 knots in the climb the aircraft struck a flock of starlings. All parameters were normal but at flight level 390 Engine 4 stalled, stalled again and after a second restart attempt the flight descended to flight level 350 but the engine would not run above 1.4 e.p.r. The flight returned. It was found that Engine 3 had minor fan blade damage and Engine 4 had extensive fan blade damage and was replaced.

31.10.86 Boeing 747(JT9D) 5R-MFT Air Madagascar Rwanda, Kanombe - -

Black Kites (Milvus migrans) were struck at 130 knots during the take-off run. A precautionary landing was made. Two fan blades were damaged in Engine 2 and four fan blades in Engine 3.

11.11.86 Jetstream 31(TPE331)N- - Colombus, US - -

During the take-off run a flock of doves was struck causing damage to Engines 1 and 2 and to the wing.

22.11.86 Boeing 737(JT8D) AP-BBC - Lahore, Pakistan - -

Birds of unknown species were struck during the climb causing damage to three fan blades in Engine 1 and to nine fan blades in Engine 2.

21.12.86 DHC-8 N- - Nr Philadelpia, US - -

While en route at 9500 feet and 210 knots a bird of unknown species struck the windshield causing a crack and complete electrical failure. Engine 1 was lost.

05.03.87 Bandeirante N890AC - Norfolk, Nebraska, US 5 -

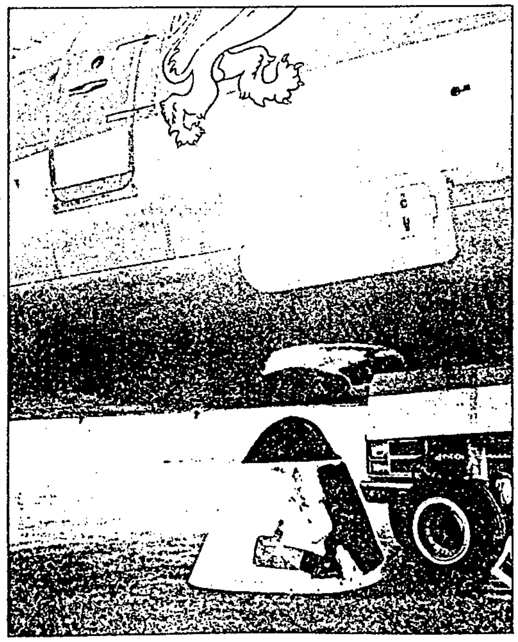
The aircraft flew through a flock of geese at 3000 feet above mean sea level during the descent and was struck by three or four. There was substantial damage to the right horizontal stabilizer and to the vertical stabilizer.

15.08.87 Boeing 747 - Air India Rome, Italy 347 -

Flock of gulls collided with the aircraft on take-off and were ingested into two engines causing fires. Take-off was abandoned but tyres caught fire. Airfield personnel extinguished the flames.

-.01.88	Boeing 727	-	Ethiopian Airlines Khartoum, Ethiopa	-	-

An eagle hit the radome as it was desce.. shed through the radome penetrating the pressure bulkhead and coming to rest against , ,t wall behind the engineers seat, tearing out wiring looms, the co-pilot's left rudder peu. severely damaging the co-pilot's left leg. Number 3 engine also sustained foreign object damage .s a result of the impact.



AEROPLANES OF 5700 KG AND BELOW

Date	Aircraft	Regn	Location	Total Aboard	Injury
09.03.85	Mooney M20	VH-MVO	Hockston Park, Australia	-	-

While in the cruise at 1500 ft and 140 knots the wing leading edge was badly damaged when the aircraft struck a flock of hawks.

03.07.85	Cessna F152	G-BKGW	Sywell, UK	1	-

Aircraft was being flown by student, returning on completion of cross country. Pilot made two go-arounds due to presence of flock of birds on runway. ATC advised birds would move out of way on his landing run. Pilot began final approach. Pilot stated that prior to touch down aircraft was struck by birds on the windscreen, wing and strut. He stated he was distracted as a flock of birds rose around him causing him to land the aircraft heavily. It bounced 10 to 15 feet and landed heavily on the nosewheel which collapsed causing propeller to strike the ground. Birds identified as rooks and some remains found where aircraft came to rest.

16.08.85	Gulfstream AA5	-	Nr Montgomery, USA	-	-

While cruising at 1500 ft and 105 knots the aircraft struck a buzzard destroying the right wing route and damaging a fuel line from the right wing tank.

17.09.85	MS890 Rallye	SEGFA	Nr Vasterlik, Sweden	-	-

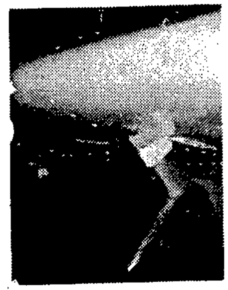
While cruising at 105 knots at 1000 ft a 20 cm hole was made in the windshield after the aircraft struck a bird of unknown species.

18.09.85	Cessna 310	-	Carrasco, Uruguay	-	-

At 3500 ft and 140 knots on the approach the wind shield was broken on the left side with inward separation fragments and frame denting after a bird struck the aircraft.

12.10.85	Mooney M20		Nr Ocean City, USA	-	-

While at 2000 ft on the approach at a speed of 120 knots the pilot heard a loud explosion and the aircraft went into a dive. He made an emergency landing at Ocean City and found the tail section twisted and bent with substantial damage due to a bird strike.



1 Nil

16.10.85 Cessna 150 G-BCKU Perth, UK

A Greylag goose (Anser anser weight 3.3 Kg) struck the pitot tube tearing the wing skin. Incident was at 600 ft and 70 knots.

11.11.85 Cessna 402 VH-ANO Batchelor, Australia - -

Just after take off the aircraft struck a Wedge tailed eagle (Aquela ordax weight 3.5 Kg) causing severe damage to the leading edge of the fin. A precautionary landing was made.

18.01.86 Beech 90 G-KFIT Edinburgh, UK - -

At 100 knots during the take-off run a flock of Black headed gulls (Larus ridibundus) was struck. The structure of the nose was deformed and the radome damaged necessitating a change. Other birds involved were Common Gulls and Herring Gulls.

02.04.86 Piper PA28 N- near Madison, Wisc, US Minor

While en route at 3300 feet a flock of ducks penetrated the windshield causing facial cuts to the pilot.

22.04.86 Socata TB20 Trinidad F-GDNA Vias, France - -

At 60 knots during the landing roll, a Little bustard (Otis tetrax weight 810gm) struck the wing leading edge holing the fuel tank causing a leak.

25.05.86 SF260 I-LELC near Alghero, Italy - -

At 4500 feet and 120 knots a bird of unknown species struck the windshield causing penetration and a hole of about 51cm diameter. A precautionary landing was made.

21.06.86 Falko F8L G-OCDS Isle of Wight, UK - -

While practising for an air race at 500 feet and 140 knots over the water, a bird entered the carb air intake and lodged in the carburettor throat totally blocking the air to the engine and causing engine failure. The pilot was able to glide to a nearby beach and make a gear-up force landing, the aircraft stopping a few inches from the rocks at the base of a cliff. The bird was a Belgian racing pigeon.

24.07.86 Cessna 152 G-BHDR Dundee, UK - -

While at 100 feet and 80 knots on the approach a pigeon broke the windshield causing a large section to almost separate from the aircraft.

23.08.86 Saab 91 SE-IRN near Lund, Sweden - -

Whilst en route at 700 feet and a 115 knots a bird of unknown species struck the link at the upper nose leg attachment causing it to fail on touchdown. As a result there was damage to the nose, propeller, exhaust and fuselage and possible crank shaft damage to the engine.

06.10.86 Cessna 150 5Y-ATB near Wilson, Kenya - -

Whilst en route at 90 knots and 6300 feet a bird of prey struck the wing causing damage to the outboard section of the tip resulting in lever arm damage to the rear spar of the wing. Estimated cost of repair 60,000 Kenya Shillings. Replacement wing probably required.

HELICOPTERS

22.08.85	Bell 206	-		Nr Venice, Luisianna, USA	-	-

While on route at 110 knots and 800 ft a flock of gulls penetrated the pilots wind shield, he was not injured.

08.10.85	Bell 206	-		Arancus City, USA	-	-

Whilst climbing out at 75 knots a gull broke the left lower pilots wind shield.

03.01.86	SA365	G-BFVV		Blackpool, UK	-	-

At 300 feet and 100 knots in the climb the helicopter struck a Black headed gull causing the pitot system to be torn off and the helicopter to return for a precautionary landing.

31.03.86	Hughes 500	N-		Lunken, US	-	-

Fifty feet in a climb the helicopter struck a flock of Starlings causing damage to the oil cooler resulting in the engine overheating, cracking the lower windshield and causing numerous dents.

13.06.86	Agusta 206	G-BCWM		St Bede, Cumbria, UK	-	Minor

Whilst on route at 600 feet and 110 knots a Herring gull holed the windscreen, bounced off the pilot's head and struck the roof window which broke. The pilot suffered slight cuts to the nose and head. A precautionary landing was made.

13.07.86	Hughes 500	G-GASC		near Biggin Hill, UK	-	-

Whilst en route at 500 feet and 90 knots the helicopter hit a flock of Swifts (Apus apus wt 40gm) causing a hole in the windshield. Live Swift was flying around inside the cockpit and the pilot had to contend with alarmed passengers the bird flying around inside together with coping with the wind blast and noise from the hole. A precautionary landing was made.

24.09.86	SA341	F-		Marignane, France	-	-

At 500 feet and 125 knots the helicopter struck a flock of Nightjars (caprimulgus europaeus wt 70gm) resulting in the windshield being penetrated. The carcass struck the rear bulkhead.

07.11.86	Bell 206	N83086		near JFK, New York	-	Serious

Gulls penetrated the windshield resulting in a precautionary landing. Serious injury resulted.

30.07.87	Bell 212	G-BFER	Bristow	near Unst,UK		Minor

While on long final approach at 300 feet and 105 knots at dusk, a Gannet (Sula basana wt 2.9kg) was seen approximately 100 yards ahead. The Gannet hit the top right hand corner of the Captain's windshield, penetrating the glass and splattering into the cockpit. The pilot's windshield was totally starred so the co-pilot took over and landed the helicopter. A crewman in the rear suffered small glass particles in his eye requiring medical attention.

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The analysis of feather remains: evaluations and perspectives

(Tim G. Brom, The Netherlands)

BSCE 19/ WP 23
Madrid, 23-28 May 1988

THE ANALYSIS OF FEATHER REMAINS: EVALUATION AND PERSPECTIVES

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ABSTRACT

Different methods of feather identification are discussed and evaluated, such as macroscopical comparison with bird skins, light-microscopy (LM), and scanning electron microscopy (SEM). Several new techniques are discussed which might be applied in the future, such as sectioning of feather parts, biochemical analysis of keratins, and analysis of chemical elements in feathers.

The results obtained in bird strike analysis in the Netherlands with LM investigation of feathers and feather fragments in combination with comparisons with bird skins are evaluated. 96% of all examined feather remains (n=1659) could be assigned to order, 71% to family, 64% to genus, and 58% to species. The Swift accounts for 24% of all identifications at species level. At family level, the Apodidae also score highest with 19%, followed by gulls and terns (Laridae & Sternidae) with 18%. At order level, the Passeriformes score highest with 40%, followed by the Charadriiformes with 26%.

INTRODUCTION

Collisions between birds and aircraft constitute a major problem to flight safety. Especially during the last decade the notion has become widely accepted that an adequate assessment of this problem by keeping accurate bird strike statistics is indispensable for taking the most appropriate preventive measures. Consequently, the search for diagnostic characters which can be used to identify those species most frequently involved, has been intensified. Besides preliminary biochemical studies on the analysis of blood and flesh remains (e.g., de Bont et al. 1986), attention has been focussed on the identification of feathers and feather fragments.

At several meetings of the Bird Strike Committee Europe (BSCE), methods of identification have been presented and evaluated, and, especially, after the formation of a Subgroup on Feather Identification within the Analysis Working Group of BSCE, microscopic identification of feathers has been discussed in detail.

The aim of this paper is to present an overview of the methods currently used and to discuss some of the results from the Netherlands. Further, the state of the art is evaluated for some techniques which might be applied to feather identification in the future.

EVALUATION OF METHODS OF FEATHER IDENTIFICATION

Macroscopical comparison of feathers

The traditionally used and most simple way of feather identification is that of comparing unknown feathers with a reference collection.

In order to be able to determine whether younger (and therefore less experienced) birds are more accident-prone than adults, a distinction between age classes is needed in bird strike statistics. Since no diagnostic characters are found in the micromorphology of feathers by which juvenile and adult birds can be distinguished, all information on the age of the bird depends on macroscopical criteria, and hence on the size and condition of the bird remains available for examination (see Table I). For some species hardly any differences in plumage exist between juvenile and older birds, whereas in others these differences are quite pronounced, at least during certain periods of the year.

Identification with light-microscopy (LM)

In the Netherlands, the identification of feathers with light-microscopy started in 1978. Based on the work of Chandler (1916) and Day (1966), an extensive LM study of the structure of downy barbules of body-feathers was performed, reference collections consisting of microscopical preparations and LM photographs were compiled, and a method

was developed for identification purposes (Brom 1980, 1986). Most feather remains can be easily assigned to the order (and sometimes to the family) to which the bird belongs. Although some authors (Hargrave 1965, Messinger 1965) have worked successfully at the species level, the differences between closely related families and, especially, species are so small that constructing a key at this level is not feasible. At our institute, feathers are identified with the key presented in Brom (1986) in combination with comparisons with the reference collection of preparations and bird skins. In case one chooses for a collection of LM photographs, two sets of prints, one arranged according to species and the other arranged to similarity of characters, provide the best use of this aid. This system was found to be most satisfactory by Messinger (1965) in his study of feathers collected at archaeological sites.

Since 1978, LM investigation of bird remains in combination with the macroscopic method has been applied as a routine procedure. The effect of the introduction of the microscopic examination of feathers, together with a more conscientious search for even the smallest feather fragments by the airfield personel, has been discussed on several occasions (e.g. Brom & Buurma 1979, Buurma & Brom 1979, Buurma 1983). A drastic shift towards smaller and darker birds took place. At order level, the detection of passeriforms increased from 9% in 1960-1977 to 46% in 1978-1983. At species level, swifts increased from 11% in 1960-1977 to 30% in 1978-1983 (Brom 1984).

Scanning electron microscopy (SEM)

Earlier studies of feathers with scanning electron microscopy (Davies 1970, Stettenheim 1976, Reaney et al. 1978, Laybourne 1984, Robertson et al. 1984, Lyster 1985, Brom 1987) have clearly indicated that SEM can contribute toward the elucidation of functional, evolutionary, and developmental aspects of feather micromorphology as well as of taxonomic and diagnostic questions. The current research of the author, subsidized by the Netherlands Organization for Scientific Research (NWO), concerns the investigation of the phylogenetic significance of characters found in the microstructure of feathers. Although the primary goal of this project is to evaluate the evolutionary polarity of these characters in order to assess the relationships between the higher taxa of birds, it is beyond doubt that also the identification work will benefit from this study. With SEM the earlier described characters (Brom 1986) can be studied in more detail. It is envisaged that new diagnostic characters will become available and that, upon completion of a reference collection of several thousands of SEM photographs, this technique can be used as a routine procedure in the analysis of bird remains in the near future.

Study of the internal structure of feather parts

Preliminary studies (e.g. Auber 1957, 1964, Swales 1970, Dyck 1977, 1978) of the internal structure of feather parts (shaft, barbs, and barbules) suggest that the cellular configurations in the medulla and cortex constitute diagnostic characters for different groups of birds. According to Swales (1970), the internal structure of barbs is constant within a species, differs from related species only in detail, and includes a basic pattern common to all species which belong to the same family. However, until now studies in this direction have been limited and the results are far from sufficient to compile a reference collection. At present no diagnostic characters are available that could be used for comparisons with unknown feathers.

Biochemical analysis of feather keratins

Feathers, scales, and skins of birds consist mainly of ß-keratins, which are highly organized and complex proteins, extremely insoluble and resistant to chemical, physical, and biological agents (e.g. Brush 1976, Fraser & MacRae 1976). This stability is due to the cysteine bonds that form within the proteins.

One of the requirements of gel electrophoresis is that the proteins under study are soluble and it is the insolubility of feather proteins that forms a major drawback in keratin studies. The results are therefore of limited value and much is still to be learned about keratins and the evolutionary significance of electrophoretic patterns. Working along different lines of biochemical analysis, O'Donnell & Inglis (1974) and Knox (1980) presented results which indicate that feather keratin molecules do have considerable potential as a source of taxonomic information. The work that has been done so far indicates that keratins represent a group of closely related gene products. The reason for the large number of keratin monomers that are known to be synthesized remains a subject of speculation (Busch & Brush 1979, Brush 1985). Some of these monomers are species specific, whereas others are tissue specific and seem to be characteristic of various feather parts such as vane or rachis, or are typically found in the pennaceous portion or downy portion (Schroeder et al. 1955, Harrap & Woods 1967, Busch & Brush 1979, King & Murphy 1987). Since data on the amino acid composition of feathers are available for only a handful of species, diagnostic characters that could be applied in identification work are not known as yet.

Analysis of chemical elements in feathers

Feathers are composed primarily of carbon, nitrogen, oxygen, and hydrogen, but about 3 dozen additional chemical elements have been found and still others are suspected. From the work of Edelstam (1969) and Kelsall (1984) it is apparent that in some cases the chemical

content of feathers reflects the composition of the local environment in which they were grown. Since the chemistry of geological areas varies, so too must the chemistry of tissues grown in different areas, particularly tissues such as feathers, which, once grown, form a closed system. Chemical profiles developed from single feathers thus may be diagnostic of the origins of birds which moult and grow new feathers in discrete areas. Colonially nesting geese in particular have been shown to be referable to their colony of origin through knowledge of the chemistry of feathers.

The methods of chemically analyzing feathers have included classical wet chemistry, atomic absorption/flame emission, and number of destructive and non-destructive multi-element analytical techniques, including the use of neutron activation, electron beams and X-rays. The potential application in bird strike analysis is evident, but the technique has yet to be field-tested on a wide basis.

RESULTS

The identification results from the Netherlands in the period that feather remains were analysed only macroscopically are as follows. In the period 1960-1975, 100% of all inspected remains (n = 119) could be assigned to a bird order, 92% to family, 88% to genus, and 74% to species. However, these results strongly depended on the skills of the investigator and on the condition of the bird remains. Smaller bird remains were neglected and therefore bird strike statistics were seriously biased by an over-representation of easily recognizable bird species.

The following is a summary of the analysis of 1659 feather remains of bird strikes in the period 1960-1987. All material dating from the period before 1978 has been rechecked both macroscopically and with LM by the author. Included are only those remains that have been received by the Zoological Museum, Amsterdam. Some 2% of the total number of remains is the result of bird strikes with civil aircraft. For these reasons the data presented in Table II should not be interpreted as representing the bird strike statistics of the Royal Netherlands Air Force. In total, 82 species of birds have been identified (eight of these came from collisions with civil aircraft outside Europe), belonging to 28 families and 12 orders. Although in all cases bird strikes could be confirmed by the presence of feather material in the samples, in 60 cases (= 4%) a more detailed identification than "Aves" was impossible. The other 1599 remains (=96%) could be assigned to order level, from which 1182 (=71%) were identified to family level, 1054 (= 64%) to genus, and 959 (= 58%) to species.

The species most frequently encountered is the Swift, with a total of 227. This is 14% of the total number of bird strikes in the period 1960-1987 (see Appendix). This bird is present in western Europe from mid April to September (the earliest collision occurred on 4

TABLE I. Age classes of 15 bird species most frequently identified in feather remains from bird strikes in the period 1960-1987, identified at the Zoological Museum, Amsterdam.

	species	n	juvenile/ immature	adult	age unknown
1.	Swift - Apus apus	227	0.4%	40%	60%
2.	Lapwing - Vanellus vanellus	104	8%	7%	85%
3.	Black-headed Gull - Larus ridibundus	66	41%	30%	28%
4.	Buzzard - Buteo buteo	53	2%	7%	91%
5.	Swallow - Hirundo rustica	51	16%	6%	78%
6.	Skylark - Alauda arvensis	47	0%	0%	100%
7.	Wood Pigeon - Columba palumbus	39	3%	3%	94%
8.	Rock Dove/Feral Dove - Columba livia	34	9%	0%	91%
9.	Common Gull - Larus canus	32	28%	56%	16%
10.	Starling - Sturnus vulgaris	26	35%	4%	61%
11.	Chaffinch - Fringilla coelebs	24	13%	0%	87%
12.	House Martin - Delichon urbica	23	4%	9%	87%
13.	Herring Gull - Larus argentatus	22	36%	64%	0%
14.	Kestrel - Falco tinnunculus	16	25%	25%	50%
15.	Partridge - Perdix perdix	15	7%	20%	73%

May, the latest on 5 September). Due to both its aerial way of life and its highly characteristic feather structure (Brom 1986), the Swift accounts for 24% of all identifications at species level (Table II). At family level, the Apodidae also score highest with 19%, followed by the gulls and terns (Laridae/Sternidae) with 18%. At order level, the Passeriformes score highest with 40%, followed by the Charadriiformes with 26% (Table II).

In all analyses of Swift remains (n=227), only one juvenile (= first calendar year) bird has been encountered, whereas at least 90 adults (= 40% of total) were involved. This result is in accordance with the fact that juvenile Swifts are only infrequently seen in feeding flocks in north-western Europe, because they migrate southward soon after they have left the nest (Cramp et al. 1985). Of all identified specimens of Herring Gull Larus argentatus (n=22), only one juvenile (first

TABLE II. Identification results obtained by macroscopic and LM analysis of feather remains from bird strikes in the period 1960-1987, identified at ZMA.

	% of total number of identified families	% of total number of identified orders
PELECANIFORMES	--	
Sulidae		--
CICONIIFORMES	1%	
Ardeidae		1%
ANSERIFORMES	3%	
Anatidae		4%
ACCIPITRIFORMES	4%	
Accipitridae		5%
FALCONIFORMES	1%	
Falconidae		2%
GALLIFORMES	1%	
Phasianidae		2%
Tetraonidae		--
CHARADRIIFORMES	26%	
Charadriidae		10%
Haematopodidae		--
Laridae/Sternidae		18%
Scolopacidae		2%
COLUMBIFORMES	10%	
Columbidae		14%
STRIGIFORMES	1%	
Strigidae		--
Tytonidae		--
CAPRIMULGIFORMES	--	
Caprimulgidae		--
APODIFORMES	14%	
Apodidae		19%
PASSERIFORMES	40%	
Alaudidae		4%
Hirundinidae		7%
Fringillidae		3%
Emberizidae		--
Motacillidae		1%
Corvidae		2%
Prunellidae		--
Ploceidae		--
Sylviidae		--
Sturnidae		2%
Turdidae		4%

calendar year) bird was found, whereas seven were immatures (2nd - 3rd calendar year) and 14 adults (older than 3 calendar years). A more even distribution of age classes was found in the Black-headed Gull *L. ridibundus*: 19 were juveniles (1st and early 2nd calendar year), 14 were adults, whereas in 13 cases the remains were to scanty to determine the age of the bird. In strikes in which the Common Gull *L. canus* was involved, nine were juveniles, 18 adults, whereas of 15 birds the age could not be established (Table I).

CONCLUSION

The reliability of bird strike statistics greatly benefits from the cooperation between aviation authorities and professional biologists. In the Netherlands, the quality as well as the quantity of feather identifications have increased significantly during the last decade on account of three reasons:

1. The improvement of the general reporting standard in the Royal Netherlands Air Force.
2. The introduction of the LM identification method as a routine procedure.
3. The skipping of identifications by non-biologists in order to keep unreliable data from the statistics.

The combination of LM examination and macroscopical comparisons with a reference collection of bird skins constitutes the most effective method at present. Whereas biochemical techniques are far from operational for bird strike analysis, the SEM method can be added as a highly effective tool to the routine procedure of feather identification. It is expected that the number of cases in which feather remains cannot be assigned to any group will be further reduced.

ACKNOWLEDGEMENTS

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APPENDIX. Species identified in macroscopic and LM analysis of feathe[r] remains from bird strikes in the period 1960-1987.

	number	% of total number of bird strikes	% of total number of identified species
PELECANIFORMES			
Sulidae			
Northern Gannet-*Sula bassana*	1	--	--
CICONIIFORMES			
Ardeidae			
Grey Heron-*Ardea cinerea*	5	--	1%
ANSERIFORMES			
Anatidae			
Mallard-*Anas platyrhynchos*	12	1%	1%
Teal-*A. crecca*	5	--	1%
Wigeon-*A. penelope*	2	--	--
Garganey-*A. querquedula*	1	--	--
Greylag Goose-*Anser anser*	1	--	--
White-fronted Goose-*A. albifrons*	1	--	--
Eider-*Somateria mollissima*	1	--	--
Goosander-*Mergus merganser*	2	--	--
ACCIPITRIFORMES			
Accipitridae			
Buzzard-*Buteo buteo*	53	3%	6%
Grashopper Buzzard Eagle-*Butastur rufipennis*	1	--	--
Black Kite-*Milvus migrans*	1	--	--
Honey Buzzard-*Pernis apivorus*	1	--	--
Sparrowhawk-*Accipiter nisus*	1	--	--
Goshawk-*A. gentilis*	1	--	--
FALCONIFORMES			
Falconidae			
Kestrel-*Falco tinnunculus*	16	1%	2%
Hobby-*F. subbuteo*	3	--	--
Merlin-*F. columbarius*	1	--	--
American Kestrel-*F. sparverius*	1	--	--
GALLIFORMES			
Phasianidae			
Partridge-*Perdix perdix*	15	1%	2%
Pheasant-*Phasianus colchicus*	2	--	--
Chukar Partridge-*Alectoris chukar*	1	--	--
Double-spurred Francolin-*Francolinus bicalcaratus*	1	--	--
Tetraonidae			
Black Grouse-*Tetrao tetrix*	2	--	--

CHARADRIIFORMES			
Charadriidae			
Lapwing-Vanellus vanellus	104	6%	11%
Golden Plover-Pluvialis apricaria	7	--	1%
Blackhead Plover-Sarciophorus tectus	1	--	--
Haematopodidae			
Oystercatcher-Haematopus ostralegus	13	1%	1%
Laridae			
Black-headed Gull-Larus ridibundus	66	4%	7%
Common Gull-L. canus	31	2%	3%
Herring Gull-L. argentatus	22	1%	2%
Lesser Black-backed Gull-L. fuscus	7	--	1%
Great Black-backed Gull-L. marinus	1	--	--
Sternidae			
Common Tern-Sterna hirundo	2	--	--
Black Tern-Chlidonias nigra	1	--	--
Scolopacidae			
Common Snipe-Gallinago gallinago	6	--	1%
Woodcock-Scolopax rusticola	2	--	--
Curlew-Numenius arquata	1	--	--
Black-tailed Godwit-Limosa limosa	4	--	--
Bar-tailed Godwit-L. lapponica	1	--	--
Ruff-Philomachus pugnax	1	--	--
Redshank-Tringa totanus	2	--	--
Knot-Calidris canutus	2	--	--
COLUMBIFORMES			
Columbidae			
Wood Pigeon-Columba palumbus	39	2%	4%
Rock Dove/Feral Dove-C. livia	34	2%	4%
Stock Dove-C. oenas	4	--	--
Turtle Dove-Streptopelia turtur	1	--	--
Collared Dove-S. decaocto	1	--	--
STRIGIFORMES			
Strigidae			
Long-eared Owl-Asio otus	2	--	--
Tytonidae			
Barn Owl-Tyto alba	1	--	--
CAPRIMULGIFORMES			
Caprimulgidae			
Natal Nightjar-Caprimulgus natalensis	1	--	--
White-tailed Nightjar-C. cayennensis	1	--	--
APODIFORMES			
Apodidae			
Swift-Apus apus	227	14%	24%

PASSERIFORMES			
Alaudidae			
Skylark-Alauda arvensis	47	3%	5%
Hirundinidae			
Swallow-Hirundo rustica	51	3%	5%
House Martin-Delichon urbica	23	2%	2%
Sand Martin-Riparia riparia	1	--	--
Fringillidae			
Chaffinch-Fringilla coelebs	24	2%	3%
Brambling-F. montifringilla	1	--	--
Linnet-Carduelis cannabina	2	--	--
Siskin-C. spinus	1	--	--
Bullfinch-Pyrrhula pyrrhula	1	--	--
Emberizidae			
Yellowhammer-Emberiza citrinella	2	--	--
Motacillidae			
White Wagtail-Motacilla alba	6	--	1%
Yellow Wagtail-M. flava	1	--	--
Meadow Pipit-Anthus pratensis	4	--	--
Tree Pipit-A. trivialis	1	--	--
Corvidae			
Jackdaw-Corvus monedula	6	--	1%
Rook-C. frugilegus	4	--	--
Carrion Crow-C. corone	1	--	--
Prunellidae			
Dunnock-Prunella modularis	1	--	--
Ploceidae			
House Sparrow-Passer domesticus	3	--	--
Sylviidae			
Blackcap-Sylvia atricapilla	1	--	--
Sturnidae			
Starling-Sturnus vulgaris	25	2%	3%
Turdidae			
Fieldfare-Turdus pilaris	14	1%	2%
Redwing-T. iliacus	10	1%	1%
Song Thrush-T. philomelos	7	--	1%
Blackbird-T. merula	5	--	1%
Mistle Thrush-T. viscivorus	1	--	--
Wheatear-Oenanthe oenanthe	1	--	--
Robin-Erithacus rubecula	1	--	--

ADF616021

Report on Preliminary Evaluation of Engine Spinner Markings

(Shinya Shima, Tokyo)

Preliminary Evaluation of Effects of Engine Spinner Marking

1. Introduction

As one of the measures to prevent bird strikes, All Nippon Airways (ANA) introduced the double offset spinner marking on the engine fan spinners of some of its fleet. This project of painting the spinner marking started in 1985 and was completed in early 1987. This paper presents a preliminary evaluation of the effects of these markings on the reduction of bird strikes to aircraft with these markings.

2. Double offset spinner marking

The dimensions of the double offset marking are as shown in Figure-1 and its appearance is as shown in Figure-2. The colors of the marking are black and white consisting of a polyurethane primer undercoat and polyurethane color coat. The cost of paint alone is approximately US$80.00 per engine. Since the design of the marking is patented, anyone who is interested in its use is requested to contact:

Manager, Legal and Insurance Department
All Nippon Airways
3-2-5 Kasumigaseki, Chiyoda-ku
Tokyo, Japan 100

3. Installation of the marking

The markings have been put only on GE CF6 series engines of ANA fleet. In other words, the markings have been put on all aircraft of B747 and B767 series listed in Table 1. However, this report only covers strike data related to 17 B747 SR's and 24 B767-200 aircraft and does not include B747 LR's or other B767s which were delivered after March 1987. The dates when the markings were painted on the spinners of engines for B747 SR and B767 aircraft that participated in this evaluation are tabulated in Tables 2 and 3 respectively. Due to varying maintenance schedules, all the engines of an aircraft were not necessarily painted on the same day as can be seen in these tables. In fact, there are only 6 B767's that had both their

engines painted on the same day. This means that the majority of the B767 fleet and all the B747 SR's were operated with both painted and unpainted engines on each aircraft for a while. The time lag between the first painted and the last painted engines of each aircraft varies from 0 to some 14 months and from 3 to 13 months for B767's and B747 SR's respectively. Thus the progress of the spinner painting project can be better expressed by the percentage of painted engines against the total number of engines rather than the percentage of aircraft with all painted engines as shown in Figures 3 and 4 for B747 SR's and B767's respectively. As is seen in these tables and figures the dates of commencement and completion of painting the markings are as follows:

	Date commenced	Date completed
B747 SR	1985/5/10	1987/2/12
B767	1985/11/06	1987/1/21

4. Bird strikes

The bird strikes which occurred to B747 SR and B767 are tabulated in different formats in Tables-4 and-5. Here it should be noted that a 12 month period of the data starts on April 1st and ends on March 31st in the following year, coinciding with the Japanese fiscal year.

Table-4 shows the bird strike rate by aircraft. It also indicates the engine strike rate per 10 000 movements, the percentage of engine strikes over total bird strikes and the rate of engine removal due to bird strikes over the total number of aircraft movements. Table-5 presents the comparison of engine strikes between engines with and without spinner markings. From these two tables the following is noted:

a) Bird strikes on B747 SRs tended to decrease both in total number and strike rate after the spinner marking project started;

b) As for B767s, the markings did not seem to produce any appreciable effects and the bird strike rate remained high, which were 15 in the last three years;

c) Engine strikes as a percentage of the total number of bird strikes is some 35% for B747 SR's in a three year period of 1984 to 1986. While that of B767's is less, varying from 18 to 24 per cent over the four year period of 1983 to 1986, the engine strike rate per engine is much higher than that of the B747 SR's; and

d) During the two year period from April 1st 1985 to March 31st 1987, aircraft with the markings show a slightly lower engine strike rate than aircraft without the markings (both B747 SRs and B767s). Engine removals due to bird strikes occurred only on B767s that did not have engine spinner markings during the same two year period.

5. Summary

Occurrence of bird strikes may vary due to various factors such as yearly variation of bird habitats or changes in carrier's route structure. Occurrence of engine removals could be considered "accidental" in nature since severity of engine damage even by same bird species may substantially vary according to the part of engine struck, i.e. at the outer circumference near the by-pass or the entrance to the core engine. Thus it would appear to be difficult to arrive at any definite conclusions from the abovementioned data of the effects of engine spinner markings, not withstanding the fact that a part of the data indicates the markings may have some positive effects.

As it was considered that the markings would not produce an adverse effect on bird strikes, the markings have now been painted on all engines of B747s and B767s in ANA's fleet. This fact also makes it difficult to compare the bird strikes between engines with and without markings. Comparison of data with another airline that operates the same type of aircraft on the same routes may be the next step to evaluate the effects of the spinner markings.

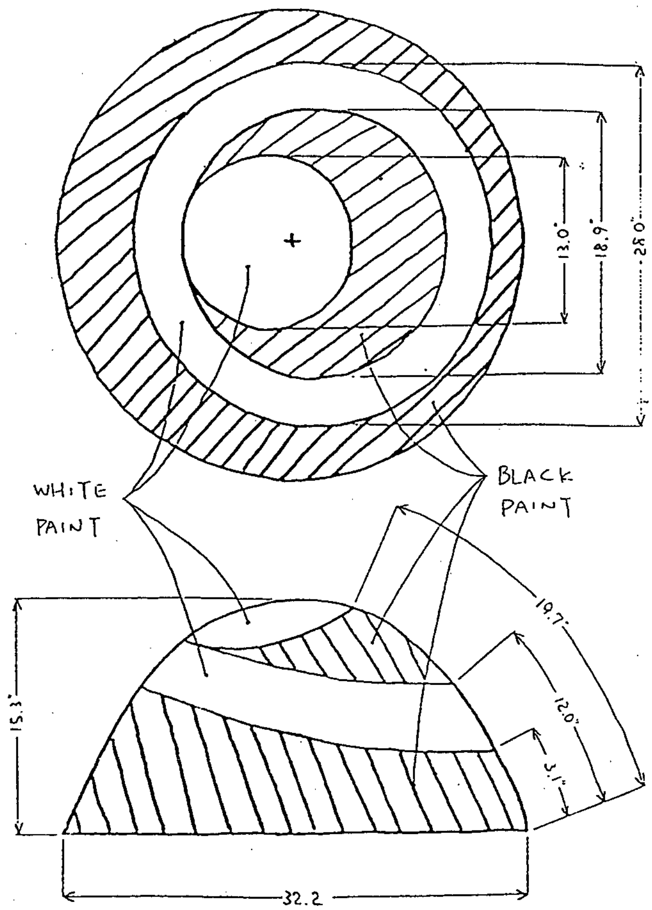

Figure-1. Dimensions of Double Offset Marking
(dimensions in inches)

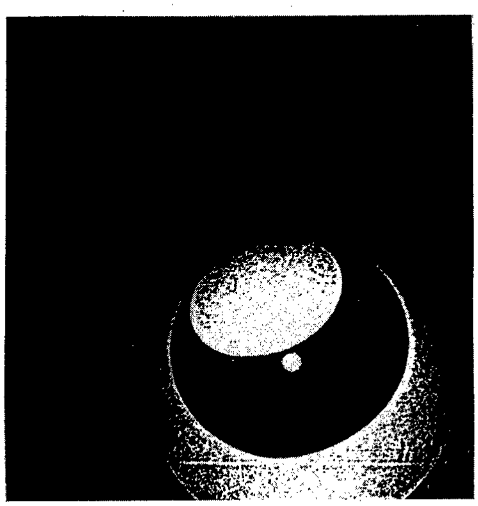

Figure-2. Phote of Doub'e Offset Marking

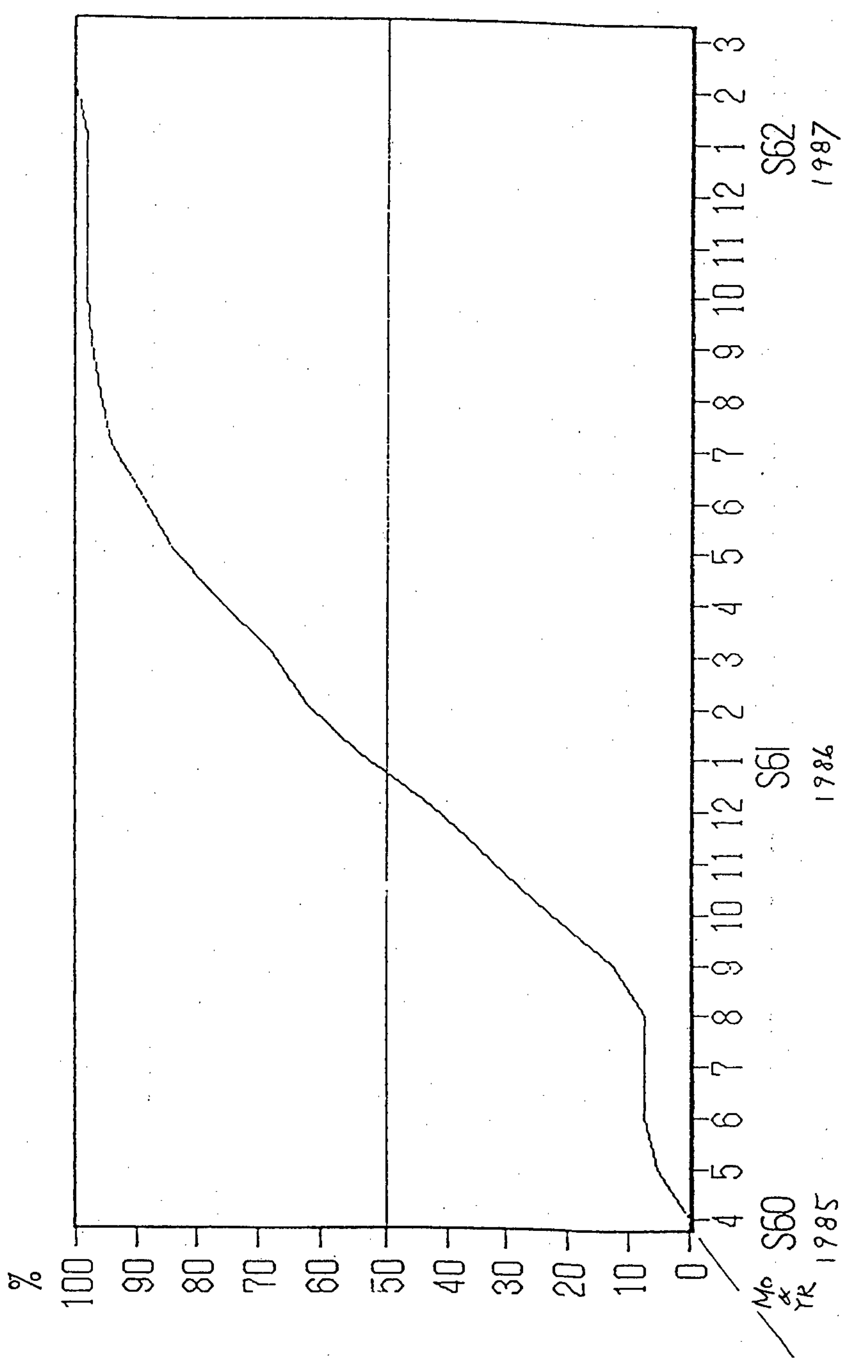

Figure-3. B747SR Marking Progress Rate

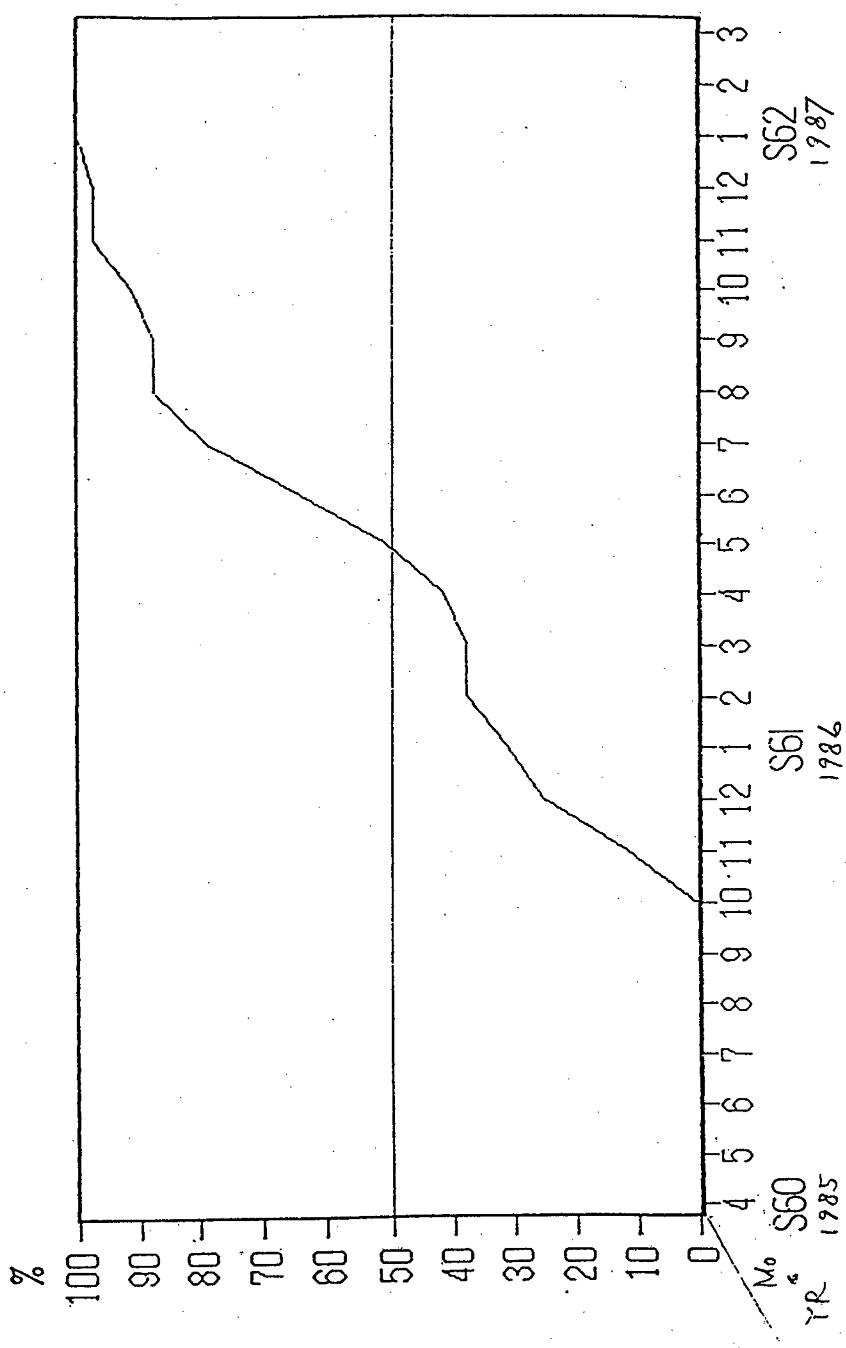

Figure-4. B767 Marking Progress Rate

Table-1. ANA aircraft List

AIRCRAFT TYPE	REGISTRATION NUMBER	DELIVERY DATE
BOEING 747SR	JA8133	79/02
	JA8134	79/01
	JA8135	79/03
	JA8136	79/10
	JA8137	79/09
	JA8138	80/02
	JA8139	80/02
	JA8145	80/05
	JA8146	80/06
	JA8147	81/02
	JA8148	81/02
	JA8152	81/07
	JA8153	81/06
	JA8156	82/07
	JA8157	82/07
	JA8158	82/06
	JA8159	83/07
BOEING 747LR	JA8174	86/07
	JA8175	86/07
	JA8181	86/12
	JA8182	87/07
BOEING 767-200	JA8479	83/05
	JA8480	83/05
	JA8481	83/07
	JA8482	83/08
	JA8483	83/10
	JA8484	83/10
	JA8485	83/12
	JA8486	84/02
	JA8487	84/02
	JA8488	84/03
	JA8489	84/07
	JA8490	84/09
	JA8491	84/11
	JA8238	85/01
	JA8239	85/03
	JA8240	85/04
	JA8241	85/04
	JA8242	85/05
	JA8243	85/06
	JA8244	85/10
	JA8245	85/11
	JA8251	85/12
	JA8252	86/07
	JA8253	86/07
	JA8254	87/04
	JA8255	87/05
BOEING 767-300	JA8256	87/07
	JA8257	87/07
	JA8258	87/07
	JA8259	87/10
	JA8271	88/02

(excludes other 50 aircraft of B727, B737, L-1011 & YS11)

Table-2. Date markings painted - B747SR

B747 SPINNER MARKING

As of 87/03/31

Aircraft No.	NO.1 ENGINE	NO.2 ENGINE	NO.3 ENGINE	NO.4 ENGINE
JA8133	85/12/02	85/12/14	86/03/13	86/03/13
JA8134	86/05/11	86/05/11	87/02/17	86/01/19
JA8135	86/04/02	85/11/04	86/03/03	86/01/19
JA8136	86/06/22	85/10/17	85/10/30	86/06/25
JA8137	85/10/21	85/09/24	86/03/10	85/09/24
JA8138	86/05/17	85/05/10	86/01/21	85/05/10
JA8139	85/09/28	86/01/30	86/02/16	85/12/02
JA8145	85/11/04	86/09/12	85/11/04	85/11/04
JA8146	85/09/24	85/10/21	85/09/24	86/01/21
JA8147	86/03/13	85/10/21	85/09/24	85/12/15
JA8148	85/05/10	86/07/14	85/09/28	86/03/20
JA8152	86/01/30	86/01/19	85/10/30	85/09/28
JA8153	86/05/23	85/10/30	86/07/14	86/05/17
JA8156	85/12/14	85/12/14	86/04/20	85/12/14
JA8157	85/05/10	85/12/15	86/06/22	86/05/11
JA8158	85/10/21	85/09/28	86/04/19	85/11/03
JA8159	86/01/30	86/03/07	85/12/02	85/12/09

Table-3. Date markings painted - B767

B767 SPINNER MARKING

As of 87/03/31

Aircraft No.	NO.1 ENGINE	NO.2 ENGINE
JA8479	86/04/02	85/11/30
JA8480	86/05/25	86/06/11
JA8481	86/01/30	86/01/30
JA8482	86/06/04	85/11/23
JA8483	86/10/09	86/07/20
JA8484	86/10/13	86/04/07
JA8485	86/06/04	86/05/14
JA8486	86/04/29	86/07/28
JA8487	86/09/08	85/11/06
JA8488	86/04/07	86/11/08
JA8489	86/05/25	86/05/30
JA8490	86/05/07	85/11/26
JA8491	86/01/22	86/07/26
JA8238	86/01/22	86/06/13
JA8239	86/01/27	85/12/27
JA8240	85/11/17	85/11/17
JA8241	86/01/27	86/07/22
JA8242	86/07/31	86/07/31
JA8243	86/11/02	85/11/26
JA8244	86/11/30	86/11/30
JA8245	87/01/21	85/11/30
JA8251	86/06/27	86/06/27
JA8252	86/07/18	86/07/18
JA8253	86/07/	86/07/

Table-4. Bird strike rate

Item		Period	83	84	85	86
			1983/4/1 to 1984/3/31	1984/4/1 to 1985/3/31	1985/4/1 to 1986/3/31	1986/4/1 to 1987/3/31
B747SR	Number of aircraft movements		42 284	52 590	58 008	61 200
	Number of bird strikes	Engine strike (strike ratio per engine)	9 (2.1)	14 (2.7)	9 (1.6)	9 (1.5)
		Total strikes (strike ratio)	22 (5.2)	42 (8.0)	29 (5.0)	25 (4.1)
	Engine strike percentage $= \frac{\text{Engine strikes}}{\text{Total strikes}} \times 100$		41%	33%	31%	36%
	Rate $= \frac{\text{Engine removal due to bird strikes}}{\text{Number of aircraft movements}} \times 10\ 000$		1.9	0	0	0
	Progress of spinner marking		0%	0%	70%	100%
B767	Number of aircraft movements		24 954	53 274	79 864	95 228
	Number of bird strikes	Engine strike (strike ratio per engine)	2 (0.4)	15 (2.8)	28 (3.5)	33 (3.5)
		Total strikes (strike ratio)	10 (4.0)	82 (15.4)	127 (15.9)	138 (14.5)
	Engine strike percentage $= \frac{\text{Engine strikes}}{\text{Total strikes}} \times 100$		20%	18%	22%	24%
	Rate $= \frac{\text{Engine removal due to bird strikes}}{\text{Number of aircraft movements}} \times 10\ 000$		0	0	0.5	0.2
	Progress of spinner marking		0%	0%	41%	100%

Table-5. Comparison of engine strikes

(Period: 1985/4/1 to 1987/3/31)

		B747SR		B767	
		With Marking*	Without Marking	With Marking*	Without Marking
No. of Aircraft Movements		70754	48454	86236	88856
ENGINE BIRD STRIKE	No. of Strikes	10	8	28	33
	Strike Rate	1.4	1.7	3.2	3.7
ENGINE REM DUE TO BIRD STRIKE	No. of Strikes	0	0	0	3
	Strike Rate	0	0	0	0.7

Note: *All engines of the aircraft are marked.

ADF616022

An overview of aerodrome bird control and related activities in the UK

(T. Brough, UK)

BSCE 19/ WP 25

Madrid, 23-28 May 1988

AN OVERVIEW OF AERODROME BIRD CONTROL AND RELATED ACTIVITIES IN THE UK

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SUMMARY

This paper briefly describes the methods used to control birds on aerodromes in the UK. Military and civil practices are compared and developments in procedures are related.

1. INTRODUCTION

The purpose of this paper is to describe, in general terms, the measures undertaken in the UK to control birds on aerodromes and in their vicinity. Reference will be made to some changes which have taken place over the years and military and civil practices will be compared.

All military flying in the UK is controlled by the Ministry of Defence (MOD) and responsibility for bird control on military aerodromes rests with a body designated C(MR)2 in the National Air Traffic Services (NATS). Previously this latter role was fulfilled by the Inspectorate of Flight Safety (IFS) which, however, remains responsible for the collection and analysis of military birdstrike statistics and maintains an interest in <u>en-route</u> and low-level strikes.

The Civil Aviation Authority (CAA) is responsible for the safety regulation of UK civil aviation. Its Directorate of Aerodrome Standards (DAS) licences aerodromes, but individual aerodrome operators are responsible for standards of aerodrome bird control. Advice is provided by DAS to assist in this task. Civil birdstrike statistics are collected and analysed by the Safety Data and Analysis Unit (SDAU) of the Airworthiness Department, another part of CAA.

Research and advice on bird control have been provided for both MOD and CAA since 1962 by what is now known as the Aviation Bird Unit (ABU) of the Ministry of Agriculture, Fisheries and Food (MAFF). Formerly this work was co-ordinated by the UK national birdstrike committee known as the Bird Impact Research and Development Committee of MOD (Procurement Executive). This committee was disbanded in 1978 although a small group, representing those parts of MOD and CAA which funded the ABU, continued to meet to review the work of the latter. At the same time, CAA arranged for an annual Bird Hazard Meeting, the purpose of which was to appraise interested parties in aviation circles about the work being undertaken by the ABU and to canvass views on areas where more work was desirable.

Having indicated the major authorities at national level responsible for regulating bird control, commissioning or undertaking research and giving advice and instruction, some of the more important activities will now be reviewed.

2. IDENTIFICATION OF BIRD REMAINS

In common with the practice in many other countries, birdstrikes are recorded on forms which are submitted to the appropriate authorities for addition to the national military and civil birdstrike databases. Because people reporting incidents frequently had difficulty in identifying the species of birds involved, they were requested in 1966 to submit remains of birds to ABU for identification whenever possible. This service has continued ever

since and the results are incorporated into the national birdstrike databases. From analysis of the data (eg Rochard & Horton 1980), it appears that the general birdstrike situation does not change markedly over a period of several years. Moreover, many poeple on aerodromes are now able to identify whole specimens of the common species quite adequately, so remains are now submitted only if the sender is unsure of the identification, thereby saving some time for the ABU.

Where the remains of birds are sparse, which is increasingly the case of those submitted to ABU, identification is assisted by examination of feather fragments under a comparison microscope using developments of the technique first described by Chandler (1916). Recognition to species level with this method, however, remains difficult. It is possible to distinguish between groups such as swans, geese and ducks but separation of the five gull species commonly occurring in European birdstrikes, and which range in weight from 275-1690 g (Brough 1983), remains problematical. Consequently, bio-chemical techniques are being investigated in attempts to resolve this difficulty.

3. BIRDSTRIKE STATISTICS AND THEIR ANALYSIS

MOD IFS analyse Royal Air Force (RAF) birdstrike data but their annual reports are not generally available. However, some information appears periodically in papers which they have produced in recent years on European military birdstrikes (eg Turner 1986).

On the civil side, CAA SDAU publishes annual analyses of birdstrikes to UK registered aircraft (eg Thorpe 1987).

It is widely recognised that the analysis and interpretation of birdstrike data are beset by difficulties. These stem mainly from the great variation both in reporting standards and in the circumstances in which the incidents occur. This generally means it is misleading to attempt to make simple comparisons between, for example, one aerodrome and another or between different airlines, yet such comparisons are invariably made. While both IFS and SDAU are aware of these shortcomings, neither has the time, staff and perhaps the necessary expertise to attempt anything better. The ABU is, therefore, trying to improve the situation by applying to the birdstrike databases more sophisticated analytical techniques generally used to analyse rather variable biological data. So far, only the civil statistics are being examined in this way and only aerodrome factors are under investigation. Subsequently the work will be extended to compare birdstrikes on different kinds of aircraft and propulsion units as well as with different species of birds. It is hoped to carry out a similar analysis on the military data.

4. SAFEGUARDING PROCEDURES

Analysis of birdstrike data leads to a better understanding of the birdstrike hazard and indicates some areas where remedies ought to be applied. It is well known that the great majority of

strikes occur on, or in the vicinity of, aerodromes and it is therefore necessary to keep these localities free of birds as far as possible. Consequently, aerodromes are safeguarded from certain developments which might cause the local bird population to increase.

The regulations concerning safeguarding against bird problems in the UK (Department of the Environment 1981) require that local planning authorities consult the appropriate military or civil safeguarding authorities regarding all proposals for potentially hazardous developments within 8 statute miles (13 km) of major aerodromes. These aerodromes include all military flying stations and most civil aerodromes used for instruction and public transport flying. Safeguarding circles with a radius of 8 statute miles are published on maps and delineate that area around an aerdrome in which aircraft, flying on a 3 degree approach, will be at, or below, 2000 feet. This is the altitude band in which 99% of "aerodrome" birdstrikes occur. Smaller aerodromes, which are not safeguarded by CAA or MOD, are advised to establish their own safeguarding procedures with their local planning authorities based on a circle with a radius of 5 miles (8 km).

Consultation is required for all applications involving landfill sites, reservoirs, sewage disposal works, nature reserves or bird sanctuaries. It also extends to works such as gravel pits and quarries which are likely to become expanses of open water or potential landfill sites in the future. It should be noted that the requirements are purely for consultation and in connection only with applications for proposed developments. There are no provisions for controlling existing features.

Consultations for planning applications affecting civil aerodromes safeguarded by CAA are undertaken by DAS who, if necessary, seek advice on ornithological aspects from the ABU. Executive authority for safeguarding military aerodromes rests with MOD PL (Lands) on the advice of NATS C(MR)2 who, in turn, obtain ornithological advice from the ABU. Every case has to be considered on its merits and subjective assessments have to be made on the potential hazards depending on the numbers and kinds of birds likely to be attracted, their proximity to aircraft movement areas, and current and projected flying activity levels.

A large number of planning applications are for landfill sites and here it is important to know what kinds of infill are to be used and their relative attractiveness to birds. Domestic refuse, irrespective of how it is treated before tipping, is invariably very attractive. In areas of dense human population, it is often difficult to find suitable sites where refuse can be dumped. There may then be strong commercial pressures to use sites which, from the bird hazard point of view, are best avoided. Sometimes it may be possible to accede to such a request on condition that bird control is carried out at the landfill site throughout the hours of daylight. The ABU has itself carried out a trial which established that bird control can be completely successful using standard measures such as broadcast distress calls and the firing of bird scaring cartridges. Great effort was made to ensure, however, that bird control was exercised continuously throughout

the hours of daylight. Unfortunately, when similar measures have been attempted by local authorities or by their contractors, it has too frequently been found that the operators have not maintained a consistent presence and birds have been able to feed. An interval of only half an hour is all that gulls may need to meet their daily food requirement and for the site to remain attractive to them. Inadequacies of this nature have to be taken into account before approval for such methods is given. The use of large nets to exclude birds from sites has proved more successful but, as this is an expensive and rather elaborate procedure, it is not used very often although it is recommended.

Another example of "safeguarding" is the annual arrangement whereby racing pigeon fanciers are notified of the requirements regarding the mass release of birds in the vicinity of aerodromes. Early each year, before the pigeon racing season begins, CAA DAS and MOD IFS produce a list of aerodromes subject to restrictions. The list is published by the Royal Pigeon Racing Association (RPRA) and thereby comes to the attention of all the major pigeon rcing organisations throughout the country. In agreement with the RPRA, no large numbers of racing pigeons are to be released within a radius of 7 nautical miles (13 km) of the 25 major civil airports licensed by CAA. For other aerodromes, all liberations within 7 nautical miles have to be notified to Air Traffic Control (ATC) in writing 14 days prior to the date of release and additionally by telephone 30 minutes before release time. On receipt of the 30-minute warning, the liberation may be delayed by up to 30 minutes, or exceptionally for a longer period, for ATC purposes. These restrictions apply to releases of large numbers of pigeons on organised races; there are currently no restrictions placed on the siting of pigeon lofts in the vicinity of aerodromes. Although such restrictions would be desirable from an air safety point of view, there is insufficient evidence to warrant the difficult task of seeking prohibitions.

5. HABITAT MANAGEMENT ON THE AERODROME

The previous section dealt with habitat management outside the boundaries of the aerodrome which is largely effected by the control of undesirable developments. This section considers habitat management on the aerodrome proper where greater control of activities should be achievable because no outside bodies are involved. However, operational requirements concerning aircraft movements impose restrictions which seriously limit the bird control measures which may be undertaken. For the main part, UK aerodromes comprise buildings, roads, taxiways, runways and grass and there is generally little that can be done to alter these features. The grass areas, however, may be very extensive.

In the UK, joint research carried out by MOD and ABU clearly indicated that airfield grass maintained at a height of 15 to 20 cm was considerably less attractive to birds than the traditional short gang-mown grass (max. 10 cm) (Brough & Bridgman 1980). As a consequence, grass is now grown up to 20 cm high wherever possible on the majority of aerodromes in the UK along the lines

of the maintenance procedures described by Mead & Carter (1973) and summarised in CAP384 (CAA 1981). The adoption of long grass as a bird control measure has been slow. This is largely because it is more expensive to maintain grass in a long, rather than short, condition and there has been a natural reluctance amongst ground maintenance staff to change established practices and to obtain new equipment. At some places there have been departures from the standard maintenance recommendations of Mead & Carter in attempts to derive a financial benefit from hay or silage crops before long grass is required to deter birds in early autumn when their numbers are increasing. Sometimes the relatively expensive annual "bottoming out" procedures in spring, intended to remove the clippings from the several topping cuts of the previous summer, are undertaken less frequently to reduce costs. As a variety of such maintenance practices appears to have developed, the ABU proposes to investigate and review the situation in the near future.

6. BIRD CONTROL - SCARING

The broadcasting of bird distress calls and the firing of bird-scaring cartridges, are the two most frequent methods of scaring birds from UK aerodromes.

A request made by the MOD in 1962 for MAFF to undertake research into the possible use of recorded distress calls resulted in the subsquent formation of the ABU. At that time, MAFF was investigating the potential use of recorded distress calls to disperse starlings Sturnus vulgaris from cherry orchards and from their roost sites (Brough 1969). The control of birds on aerodromes necessitated the recording and field testing of distress calls of different species (eg gulls (Laridae) and lapwing Vanellus vanellus). Some of this work was done co-operatively with the Laboratoire des Petits Vertebres and the Laboratoire de Physiologie Acoustique of the Institut National de la Recherche Agronomique of the French Ministry of Agriculture (Bremond et al. 1968). Recordings made by ABU at that time are still widely used both in the UK and in other countries. (Copies for use on aerodromes and elsewhere are available commercially from Wingaway, North Reston, Louth, Lincs, LN11 8JD, UK).

The original research and development work on distress calls resulted in the commercial production of broadcasting equipment known by its trade name of SAPPHO. Various versions of this equipment were widely used on aerodromes but production ceased several years ago. At that time, good quality in-car cassette equipment produced by various manufacturers was appearing on the market. The ABU investigated simple modifications of this equipment for broadcasting bird distress calls and subsequently encouraged aerodrome operators to use this cheap alternative (Horton 1979). Such bio-acoustic bird-scarers (BABS) are now widely used on UK aerodromes although some custom-built equipment is now also produced by a few manufacturers for use on aerodromes, farms and elsewhere.

The firing of bird-scaring cartridges, or shellcrackers as they are commonly called, is often carried out as a supplementary aid

to playing distress calls. They are also used on their own although then they may become less effective if fired too frequently. They are, however, very popular and are perhaps the most widely used single bird-scaring device on UK aerodromes.

The shellcrackers employed are all 12 bore and they are often fired from a 1.5 inch signal pistol, using an adaptor sleeve to accommodate the smaller cartridge, but some custom-made pistols are also employed. The cartridges are never fired from shotguns. Certificates for the possession and use of pistols and cartridges must be obtained from the local police and there are strict requirements regarding the storage, transportation and use of these items.

7. BIRD CONTROL - KILLING

Birds are shot on some aerodromes but only when all other methods of control have been tried and have failed for some reason. In common with legislation in other EEC countries, the Wildlife and Countryside Act 1981 protects all species of wild birds although a small number of common pest species can be killed by authorised persons ie. land-owners or persons authorised by land-owners. But, in particular, and under the terms of a general licence, common airfield species such as the lapwing, black-headed gull Larus ridibundus and common gulls L. canus, (and on some named aerodromes, oystercatcher Haematopus ostralegus) can be killed for the purposes of flight safety. The only practical way of taking these birds on an airfield is by shooting and this limits the number of birds likely to be taken at any time but it is perfectly adequate as a reinforcement to the more usual scaring measures and to enhance the response of birds to shellcrackers, for instance.

Under the conditions of the licence to kill or take birds on aerodromes, an annual report has to be sent to the Department of the Environment (DOE) which administers the Wildlife and Countryside Act. MOD aerodromes belong to the Crown and are not therefore subject to the regulations but MOD has undertaken to abide by the spirit of the Act. As aerodrome operators submit their information direct to DOE, it is unlikely that the aviation authorities will be aware of the amount of killing which is undertaken for flight safety purposes.

In exceptional circumstances, such as when colonies of breeding herring gulls occur on aerodromes or on air weapons ranges, licences may be obtained to use stupefacient baits in order to take and remove birds (Rochard 1987). These measures are generally carried out, or supervised by, ABU and are never undertaken lightly.

The use of falcons is included under this heading because it may entail some killing to reinforce scaring potential. As a general rule, falcons and hawks are rarely used to control birds on aerodromes in the UK, and then only on a small number of military aerodromes.

For example, the Royal Navy has for many years used falcons as an aid to bird control in conjunction with standard methods on two or three of its aerodromes and has derived some benefit from the publicity value associated with these birds. Some of the civilian contractors employed to control birds on RAF airfields (described below) also have the facility to use these birds, as do some contractors employed on specialised MOD (Procurement Executive) airfields and on those used by the United States Air Force Europe in the UK.

8. BIRD CONTROL ORGANISATION

On the military side, responsibility for carrying out bird control on aerodromes has traditionally resided with the Airfield Fire Service (AFS) who were asked to scare birds on the airfield, as the need arose, by ATC. This situation produced rather variable results depending upon the enthusiasm of the many individuals involved, some of whom were clearly not very keen or effective. In the early 1960s, MOD gave further consideration to the use of falcons and hawks as a means of controlling birds on aerodromes. The ABU were of the opinion that full-time bird controllers, who had no extraneous duties, would be as effective, using basic techniques such as distress call broadcasts and the firing of shellcrackers, as the falconers, and this view prevailed. After a trial of Bird Control Units (BCUs), each consisting of one Junior Non-Commissioned Officer and two Senior Aircraftmen, the RAF manned some 20 of its major aerodromes in this way, the remaining stations continuing as they had done before. The staff chosen for the BCUs were all volunteers and were trained by the ABU.

This situation worked effectively for some time, although some dissatisfaction was felt regarding the line management of the BCUs. This was resolved when IFS relinquished its responsibility for providing advice on bird control within the RAF to NATS when it was decided that BCUs should be staffed by ATC personnel. Some time later, a Central Bird Control Co-ordinating Officer (CBCCO) was appointed within NATS C(MR)2 to provide specialist supervision for BCU activities. A subsequent decision resulted in a further change and, over a period of years, the BCUs are progressively being civilianised in groups of about four or five adjacent aerodromes at a time. The contractor for each group employs a regional manager who has overall responsibility for the aerodrome managers and their operatives. Unlike their military predecessors, some of the staff employed in these civilian units have biological qualifications.

Understandably, the civil side does not have the same kind of unified approach to bird control as the military and there is greater scope for diversity. As on the military side, bird control has frequently been undertaken by ATC or, perhaps more frequently, by AFS at the behest of ATC. At some airports, and particularly the larger ones operated by BAA plc, there are Manoeuvring Area Safety Units or similar groups which, apart from other duties, maintain a mobile bird control presence, like that of their military counterparts, throughout the operating hours of the airport. On

large airports, the staff work on a shift basis. At smaller airfields, the same one or two individuals might be employed throughout the working day. Manchester International Airport is unusual in that it has a small specialist team devoted solely to bird control and headed by a qualified biologist.

The requirement for civil aerodromes to carry out bird control stems from the Air Navigation Order which stipulates that aerodromes used for most instruction and public transport flying must be licensed by CAA. Before granting a licence, CAA must be satisfied that the applicant is competent and experienced and has the necessary arrangements to ensure that the aerodrome is safe for aircraft. Included amongst these arrangements is the requirement that it must have prepared an Aerodrome Manual. This describes for aerodrome operating staff the procedures relevant to their duties, including those for the control of bird hazards. The CAA must be satisfied that the procedures laid down for bird control in terms of bird detection and dispersal by means of habitat management and scaring measures etc. are adequate in relation to the perceived nature of the bird problem and the kind and amount of air traffic. When an aerodrome is licensed, it is subject to periodic inspections from the Authority's aerodrome inspectors on a variety of technical aspects associated with aerodrome operations, and bird control practices are monitored. At less frequent intervals, ABU are requested to carry out surveys of birds and related control matters on aerodromes and provide specialist advice.

9. ADVICE AND TRAINING

Basic advice and recommendations on bird control on aerodromes are contained in CAP384 "Bird control on aerodromes" published by CAA. On the military side, the Joint Services Publication 318A Annex 6 fulfils a similar role and is based on the same information but it contains some details appropriate only to service operations. This latter document is not on general release outside the service. In addition to these two publications, ABU produces reports on aspects of bird control of interest to aerodrome operators (eg Horton 1986, Brough 1987, Milsom & Rochard 1987) and these are generally distributed to all major aerodromes by CAA and MOD as appropriate. ABU also publish their research findings in the scientific literature so that they are more widely available.

Aerodromes which are experiencing problems with bird control or related matters can obtain advice from CAA Directorate of Aerodrome Standards or the Central Bird Control Co-ordinating Officer in NATS. If necessary, the assistance of the ABU is called for; this is in addition to the periodic surveys of aerodromes which CAA or NATS may request.

Training courses for staff engaged in any capacity on bird control on aerodromes have been held at least annually by ABU since 1966. The first course was arranged specifically to train RAF instructors when distress call broadcasting equipment was generally introduced on to military airfields. Subsequently, the courses were increased to accommodate 30 people at a time from both military and civil

aerodromes. Recently, with the advent of civilian BCUs on RAF airfields, the military training requirement has decreased but courses for staff from civil aerodromes continue and these are all now held at a CAA venue and are arranged by CAA DAS. Basic bird control courses last one week but some three-day courses have recently been provided for more senior staff and as refresher courses for those who have received earlier training.

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United States Air Force Bird Strike Summary (1986-1987)

(Russell P. De Fusco, Capt, USAF)

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UNITED STATES AIR FORCE BIRD STRIKE SUMMARY 1986-1987

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The United States Air Force recorded 5,324 bird strikes during 1986 and 1987. These strikes resulted in the loss of four aircraft, six lives, and over $260,000,000 in damages. Strike records are summarized by aircraft involved in incidents, impact locations, birds involved in strikes, phases of flight, times of day and year when strikes occurred, and altitudes where strikes were reported. These data are used to focus bird strike reduction efforts by the US Air Force.

<u>UNITED STATES AIR FORCE BIRD STRIKE SUMMARY</u>
<u>1986-1987</u>

The United States Air Force recorded 5,324 bird strikes during 1986 and 1987. These strikes resulted in the loss of four aircraft, six fatalities, and over $260,000,000 in damages. The Air Force Bird Aircraft Strike Hazard (BASH) Team maintains all USAF bird strike records reported by each of its installations. Trend information is used for formulating management strategies and to focus BASH reduction efforts throughout the USAF. The following is a summary of the incidents recorded during 1986 and 1987.

1. <u>Major USAF Mishaps</u>.

The USAF suffered five mishaps which resulted in lost aircraft or greater than one million dollars in damages during 1986 and 1987.

a. In October 1986, an F-4 from Moody Air Force Base, Georgia struck a 4.5 pound Black Vulture (<u>Coragyps</u> <u>atratus</u>) near Savannah, Georgia. The bird penetrated the fuselage alongside the engine nacelle, severing fuel lines. An intense fire erupted and the crew ejected. The weapons systems officer escaped without injury, but the pilot was killed during the ejection sequence. This incident cost the Air Force $4,940,393.

b. Another accident in October 1986 occured when an F-16 from Torrejon Air Base, Spain struck a 16 pound Griffon Vulture (<u>Gyps</u> <u>fulvus</u>) on the Bardenas Reales Range. The bird impacted the engine inlet. Pieces of the inlet and bird remains were ingested causing complete destruction of the engine and an in-flight fire. The pilot ejected safely. Total cost of the mishap was reported as $9,512,830.

c. In May 1987, an F-4E on deployment from Spangdahlem Air Base, Germany struck a 16 pound Griffon Vulture (<u>Gyps</u> <u>fulvus</u>) on the Bardenas Reales range in Spain. The bird penetrated the windscreen and canopy of the aircraft striking the pilot and killing him instantly. Bird remains and pieces of canopy ripped through the cockpit impacting the weapons systems officer. His injuries and visual impairment caused by the strike prevented escape from the aircraft and he was killed upon ground impact. Reported costs were $17,000,000 in this incident.

d. In September 1987, a B-1B on a low-level training mission from Dyess Air Force, Base Texas struck a 16 pound American White Pelican (<u>Pelecanus</u> <u>erythrorhynchos</u>) near LaJunta, Colorado. The bird severed fuel and hydraulic lines causing an intense fire. Aircraft control became impossible and the crew initiated ejection. Three crew members ejected successfully. The three remaining crew

members were killed upon impact with the ground. The Air Force lost $215,323,000 in this accident.

e. In December 1987, an E-4 (Boeing 747) struck approximately forty Snow Geese (Chen caerulescens) shortly after takeoff from Offutt Air Force Base, Nebraska. The crew jetisoned fuel and managed to land safely despite extensive damage to the airframe and engines. Both wings, the radome, and two engines sustained significant damage costing over $1,650,000.

These examples are but a few of the devastating effects birds had on our aircraft in 1986 and 1987.

2. Aircraft Involved in Bird Strikes.

Virtually every aircraft in the USAF inventory reported bird strikes during 1986 and 1987, although aircraft mission played a major role in frequency and severity of strikes. Aircraft which flew high-speed low-level missions were much more likely to encounter birds than those which spent more time at higher altitudes. Additionally, aircraft size, configuration, airspeed, geographic location, and type of engines affected susceptibility to strikes.

Figure 1 shows that USAF fighter and cargo aircraft led the list in most strikes. The number of aircraft involved, hours flown, and low-level mission profiles influence this fact, yet other aircraft such as our bombers actually report more strikes per flight hour.

3. Impact Locations.

Any part of an aircraft can be, and has been, struck by birds (Table 1). It appears that the probability of a strike is directly proportional to the frontal surface area exposed to the windstream. Because the severity of damage is often a matter of luck and inches, the USAF requires all strikes, regardless of damage, to be reported. Every effort is made to identify the species involved in the strike to determine appropriate avoidance or control measures.

TABLE 1. Bird Strikes by Impact Location
1986-1987

Impact Point	Percent of Total
Windshield/Canopy	21.4
Engine/Cowling	17.9
Wings	17.0
Radome/Nose	16.1
Multiple Locations	9.8
Fuselage	8.0
External Tanks/Pods/Gear	7.2
Other	2.6

4. Birds Involved in Collisions With Aircraft.

A wide variety of bird species are involved in collisions with aircraft. Post-strike feather identification is an important aspect of BASH management strategies. Microscopic and macroscopic techniques are used in determining the species involved in bird strike incidents. Table 2 is a partial listing of the most common broad categories of birds involved in bird strikes.

TABLE 2. Birds identified in Aircraft Collisions 1986-1987

Birds	Number Identified
Hawks/Vultures	337
Gulls	218
Blackbirds and Starlings	125
Pigeons and Doves	122
Waterfowl	96
Horned Larks	85
Meadowlarks	77
Shorebirds and Herons	56

Raptors and gulls lead the list of most commonly struck birds. Raptors were a major hazard on our low-level flights, while gulls were primarily encountered in the airdrome environment.

5. Bird Strikes by Phase of Flight.

Birds were encountered by USAF aircraft in every flight profile during 1986 and 1987. The majority of strikes occurred in the airdrome environment, but strikes incurred on low-level and range operations vastly outweighed the airfield strikes in damages caused. Figure 2 shows the percentages of strikes reported during various phases of flight. Management of airfield environments to reduce bird populations and the use of dispersal techniques have greatly reduced the severity of airfield bird strikes, and the USAF did not lose any aircraft in this environment during 1986 and 1987. The USAF is beginning to focus its BASH reduction efforts on the areas away from the airfield. Unfortunately we have much less control over these areas and much is to be learned about avoiding birds in these remote areas. Flight scheduling and route development for bird avoidance is increasingly emphasized by the USAF.

6. Times When Bird Strikes Occur.

The USAF does most of its flying during the day; so naturally, most of our bird strikes happen then. Figure 3 shows that nearly 70% of reported strikes occurred during daylight hours in 1986 and 1987. Most strikes repored at night occurred during migratory periods. Flights were frequently scheduled to avoid major bird activity periods such as around dawn and dusk, but a significant number of strikes occurred during these times.

Figure 4 shows bird strikes reported by month. The largest numbers of strikes were recorded during fall migratory periods with smaller peaks occurring during spring. Birds often congregate on even the most well-managed airfields during migrations and must be actively dispersed during these times. Flight scheduling to avoid birds is the only way to limit strikes during migratory seasons away from the airfield.

7. Bird Strikes by Altitude.

Figure 5 shows that over 96% of USAF bird strikes were recorded below 3,000 feet above ground level. These numbers reflect that bird densities increase dramatically as altitude decreases. Raising altitude in the traffic pattern or on low-level flights is important to reduce bird strikes whenever missions permit.

8. Summary.

The United States Air Force continues to suffer tremendous losses to bird strikes each year. 1986 and 1987 were disasterous years in terms of aircraft damage and lost lives. USAF experience in the past 2 years has caused a great deal of interest in BASH reduction efforts. Much needs to be done in reducing the hazards away from our airfields. The USAF considers development of complete bird population and movement data and issuance of bird hazard advisories in our low-level and operating areas among its top priorities for future reduction of bird strike hazards. Armed with this information, we anticipate safer flying conditions and substantial savings of resources throughout the US Air Force.

Figure 1.
Bird Strikes By Aircraft Type
1986–1987

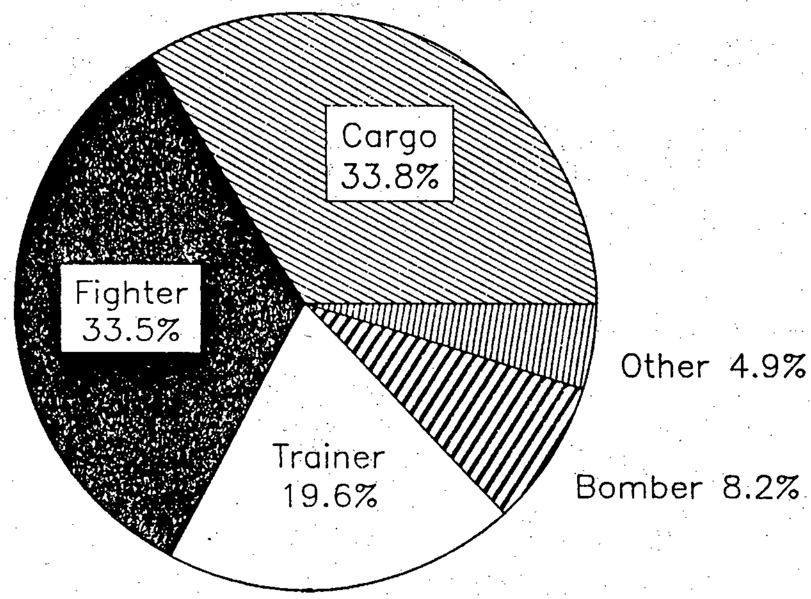


Figure 2.
Bird Strikes by Phase of Flight
1986–1987

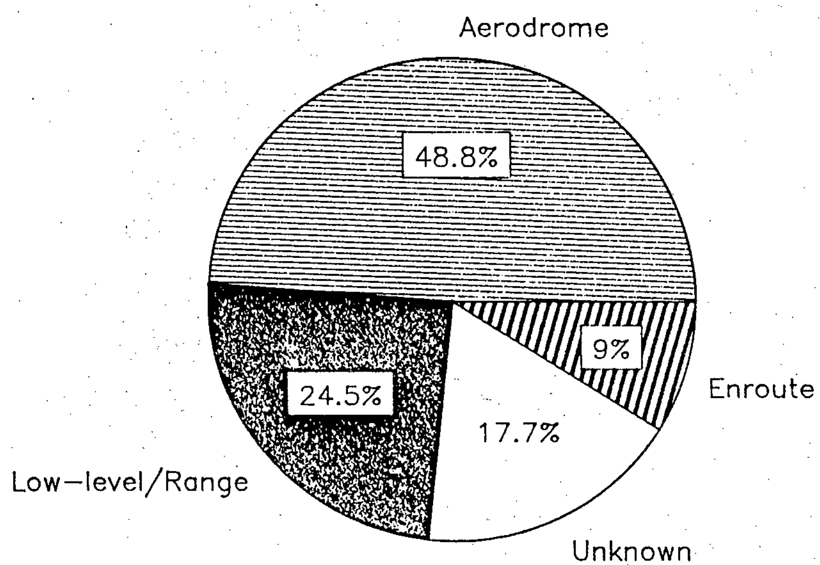


Figure 3.
Bird Strikes by Time of Day
1986–1987

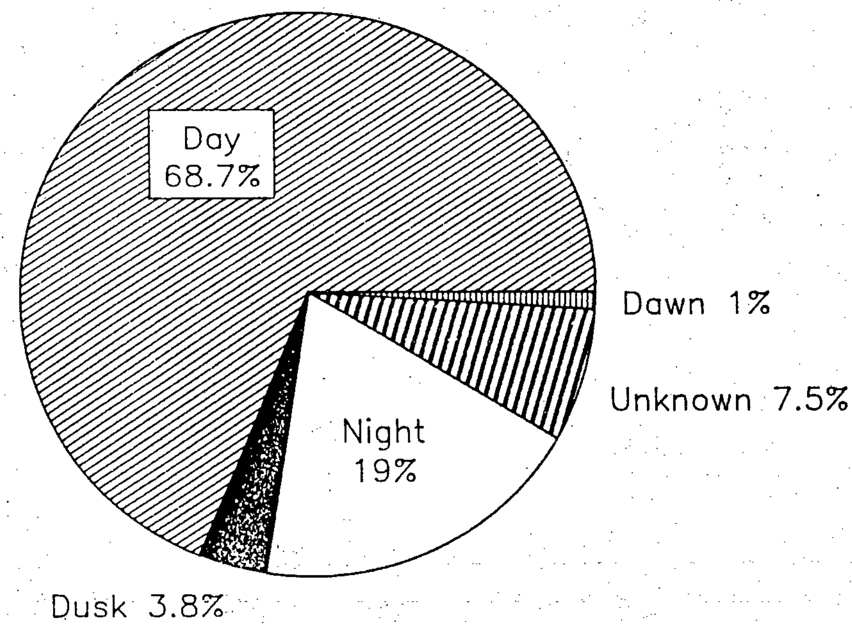


Figure 4.
Bird Strikes by Month
1986—1987

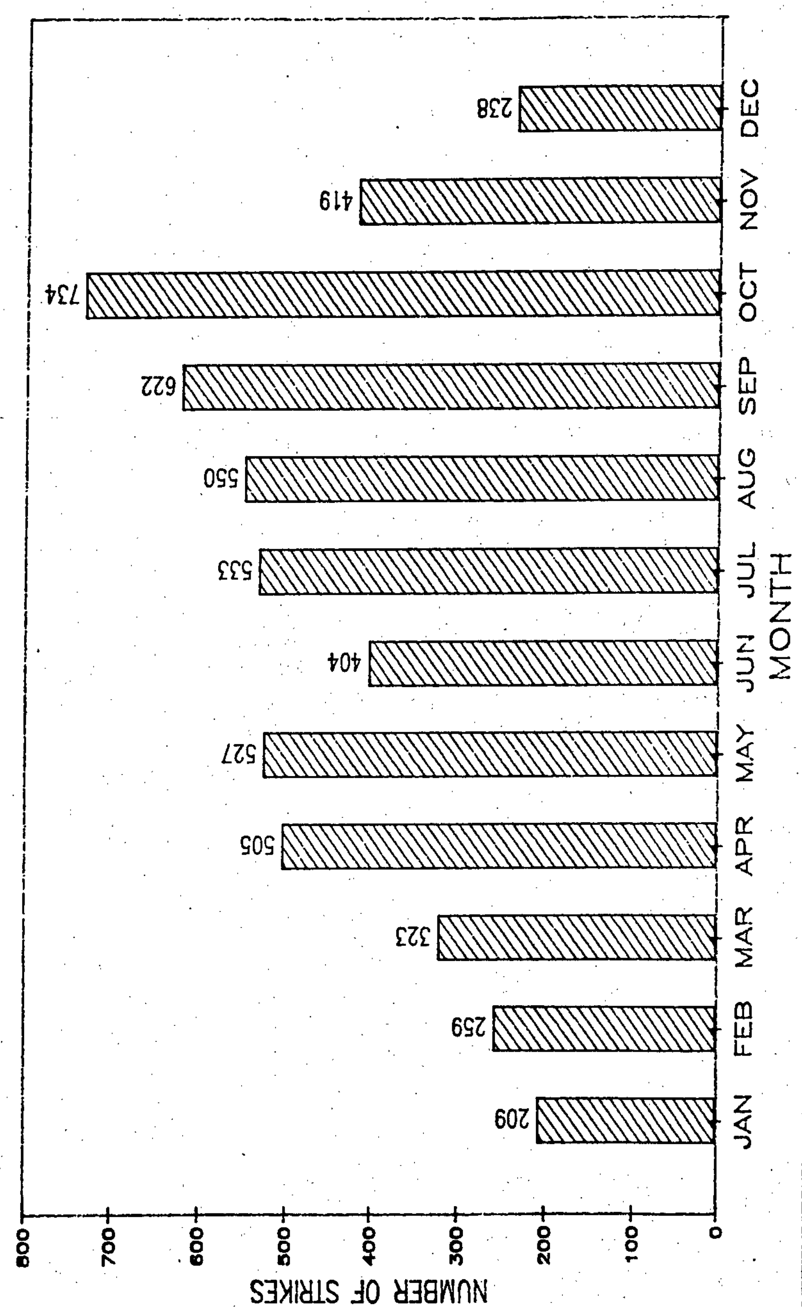
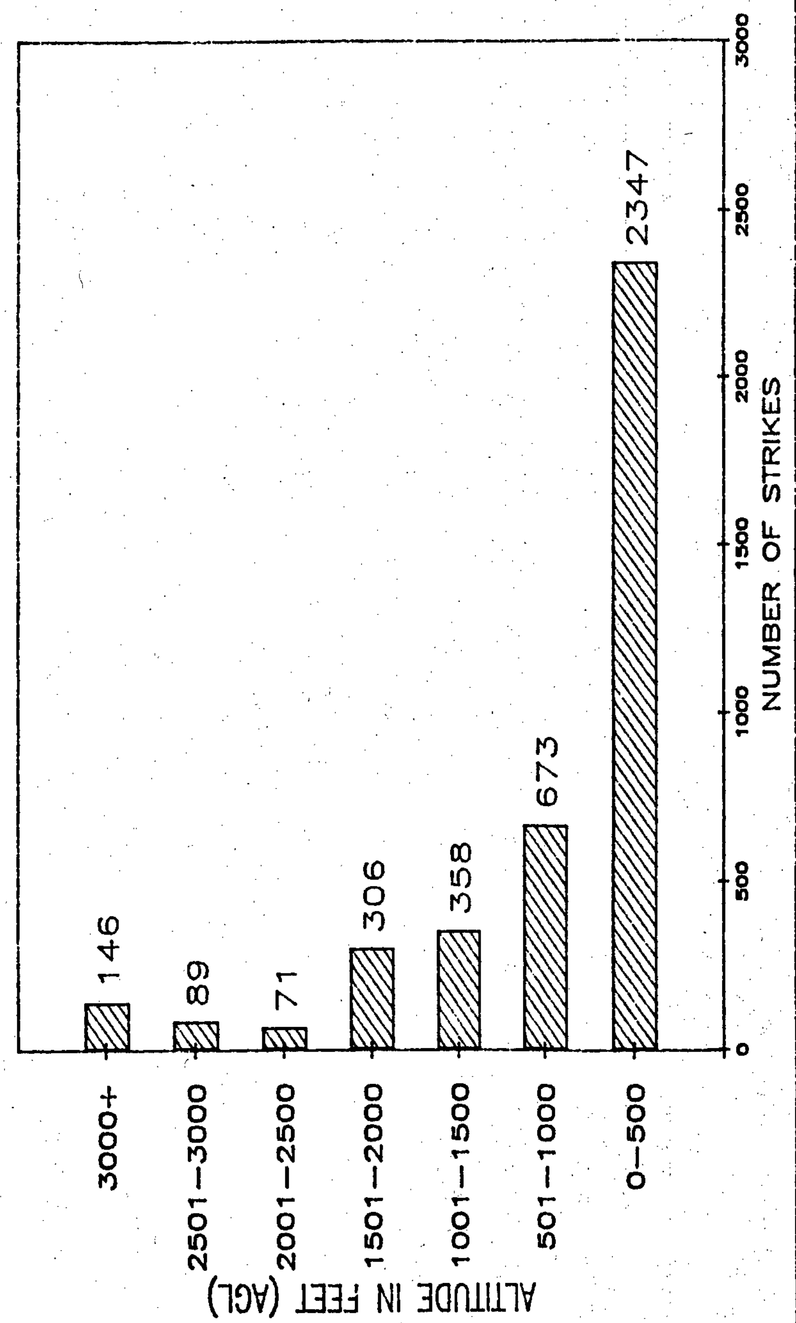


Figure 5.
Bird Strikes by Altitude
1986—1987



ADF616024

Visual Lapwing Counts Versus Aircraft-Lapwing Strikes

(A. Dekker and L.S.Buurma, The Hague)

BSCE 19/ WP 27

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VISUAL LAPWING COUNTS VERSUS AIRCRAFT-LAPWING STRIKES

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SUMMARY

Using very frequent birdcounts, from 6 RNLAF airfields during the years 1982-1987 the pattern of presence of the Lapwing (Vanellus vanellus) during the year was defined. Differences between the 6 airfields can be explained geographical location (surroundings) and the agricultural management of the airfield and surroundings. Comparison with quantitative information on the autumn presence of the Lapwing in the Netherlands reveals that the "bird unfriendly" management of the airfields does pay off in the sense that numbers of the Lapwing on the airfields are relatively low. The distribution of Lapwing strikes over the year shows distinct peaks in early spring, mid summer and especially in autumn (october). The high number of strikes in autumn appears to be caused mainly by local strikes. However, the relation between the presence of Lapwings on the airfields and the number of local Lapwing strikes is poor and certainly not a simple one. The chance on a collision is not determined by the actual number of Lapwings on an airfield but by the flying activity of Lapwings around and over airfields. Effective countermeasures include the removal of flocks and the adaptation of aircraft movements.

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INTRODUCTION

At the bird hit parade from civil as well as military bird strike statistics the Lapwing (Vanellus vanellus) has since long scored in the upper regions. From 7381 registered birdstrikes with European registered civil aircraft during the period 1976-1984, the Lapwing was involved in 923 cases (12.5%)(refs.1,2,3). In the incomplete military statistics over the period 1977-1984 (mainly involving data from RAF; GAF; SAF; RDAF) out of 3956 birdstrikes 366 times (9.3%) the Lapwing turns out to be the victim (refs.4,5,6,7,8,). In the RNLAF bird strike data over the period 1977-1987 the Lapwing is also well represented. In 89 out of 1832 cases (4.9%) this species was involved.

In order to assess wether prevention of Lapwing strikes is feasable and what kind of prevention is likely to be most succesful it is nessecary to know where, when and why Lapwings do form a threat to flight safety. We use weekly bird surveys at all Dutch fighter bases to study the potential danger of the species, and check this with the Lapwing strikes that actually occured.

2. MATERIAL AND METHODS

2.1. The Lapwing in Europe in a broader perspective.

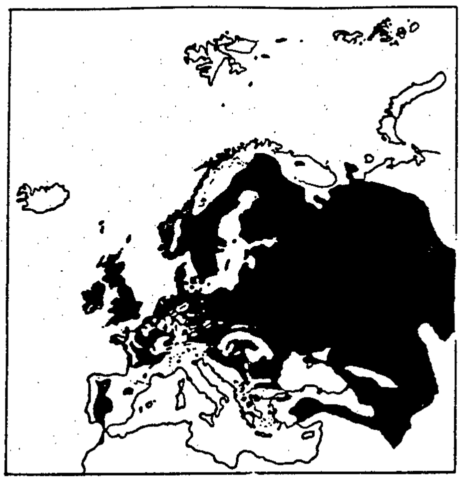
The Lapwing is a bird typical for open, more or less flat terrain on an altitude which normally does not exceed 1000 m. The distribution over Europe is given in figure 1a (ref.9). This map just gives the pattern of presence but no quantitative information. The highest densities of breeding birds are found in the North German and Dutch lowlands and especially in the grassland areas of NW-Netherlands. The total number of breeding Lapwings in NW Europe (excluding UK and Ireland) is estimated at 500 to 800 thousand pairs. Of these, over 200 thousand breed in the Netherlands (refs.9,10). Adding information about the number of breeding pairs to fig. 1a leads to fig 1b. Here the mere presence of the species as given in figure 1a is set in the perspective of numbers.

Predominantly living of soil invertebrates, the Lapwing probes the top layer of the soil in order to catch prey which is located by sight and sound. For the majority of the birds this way of feeding makes it impossible to stay in the breeding area all year round. So migration takes place on a rather large scale.
The first migrants, together with dispersing young birds are responsible for the complex movements of Lapwings over Europe which do start immediately after the breeding season. Without going into detail these movements result in a general move in South-Westerly directions as is shown in figure 1c in which the the migration routes of Lapwings from different populations is shown (ref.11).

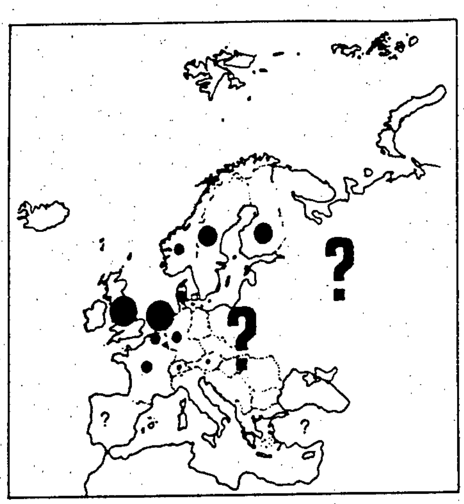
In addition it is neccesary to know that autumn migration does not take place in one rush but results in accumulating numbers of Lapwings in the North German and Dutch lowlands. These birds generally do not leave before frost and snow make it impossible to feed. This behaviour is responsible for the so called hard-weather movements, sometimes involving huge numbers of birds.

From figures 1b and 1c it is clear that the North German and Dutch lowlands are used for a longer or shorter period of time by the majority of the NW European populations of the Lapwing.

There are indications that some behavioural aspects of the Lapwing have changed over the last 10 to 20 years. These changes are supposed to be the result of adaptations to the radically changed agricultural landuse. In the Netherlands for instance breeding on ploughed fields now is a common phenomenon (ref.12) whereas in earlier times breeding was restricted to grassland. Not only breeding habitat but also breeding season has changed. Ringing data of chicks suggest that breeding starts about a week earlier (ref.13).



a



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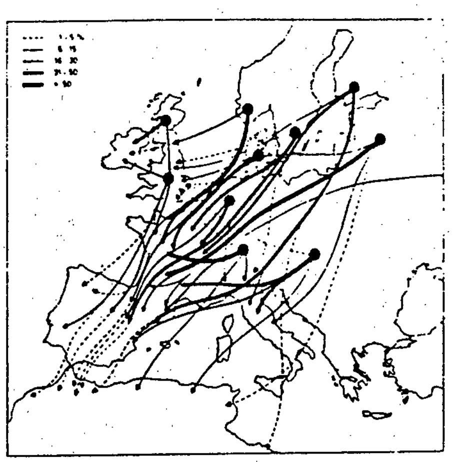

c

Figure 1:

a. Breeding distribution of the Lapwing.

b. Number of breeding pairs of Lapwing per country.

- < 10,000 pairs
- 10,000-100,000 pairs
- 100,00-200,000 pairs
- > 200,000 pairs

c. Autumn migration routes of different populations of European Lapwing.

Data from refs 9 and 11.

2.2. The presence of Lapwings on RNLAF-airfields

One of the standard daily activities of Bird Control Units (BCU's) is the early morning survey, which is done before the start of flight operations (ref.14). Once a week but in later years often more frequently, this quick survey is extended to a standard count of all birds present per airfield section.

BCU personnel is well trained for this task because detailed instructions are given and regular evaluations are made. Therefore we believe the collected data are very reliable. On average such an extended survey takes about 45 min. to complete. Simulation experiments with data collected on a nearly daily base learned that the minimum counting frequency providing reliable patterns is once in a week.

The patterns of presence during the years 1982-1987 were established for 6 airfields. The characteristic yearly pattern for each airfield was then obtained by calculating the (three week) running weekly mean for these six years. The total number of counts during the 6 year period on the 6 airfields is 2380.
The breakdown over the years and airfields is given in tabel 1 while the number of counts per week and per airfield is visualized in fig. 2.

Tabel 1. The number of bird counts per airfield and per year.

YEAR AIRFIELD	1982	1983	1984	1985	1986	1987	TOTAL
Leewarden	69	44	56	49	45	149	412
Twenthe	63	144	175	76	97	83	638
Soesterberg	90	82	45	46	42	72	377
Volkel	34	39	34	41	39	73	260
Eindhoven	44	87	68	46	43	84	372
Gilze-Rijen	82	44	28	42	43	82	321
TOTAL	382	440	406	300	309	543	2380

2.3. The Lapwing in the RNLAF bird strike statistics.

Since the introduction of jet engines, the bird strike risk in military operations has increased significantly. This lead to more emphasis on collecting proper statistics of bird strikes. Hence, reliable data are available from 1960 onwards. Determination of the bird species involved was done by the zoological museum of the University of Amsterdam. From 1977 onward the microscopical method of determination has greatly improved the quality and the number of succesfull determinations of bird remains (ref.15). For this analysis we selected all "Lapwing strikes" with jets from 1960 up to and including 1987.

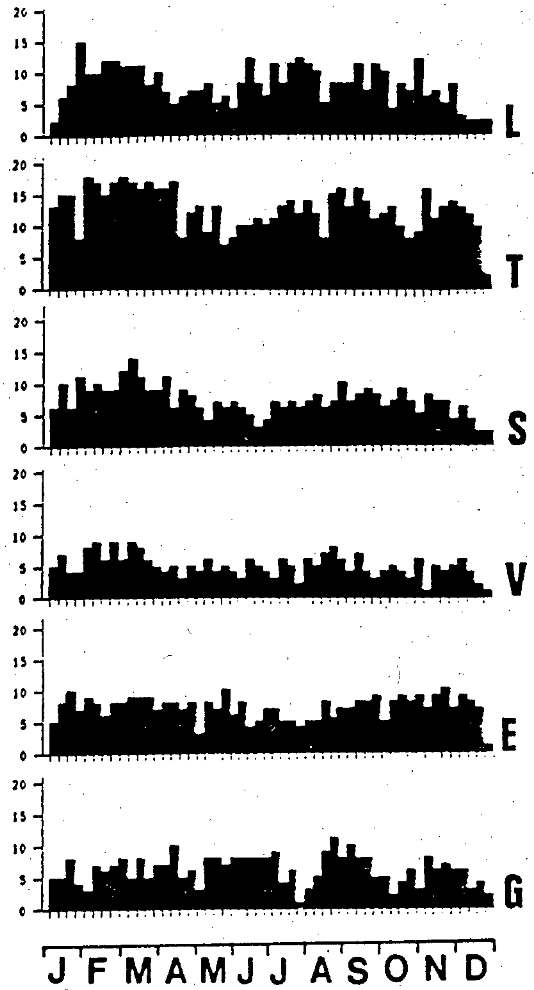

Figure 2:

Number of available counts per week during the period 1982-1987 for 6 RNLAF airbases.

L = Leeuwarden
T = Twenthe
S = Soesterberg
V = Volkel
E = Eindhoven
G = Gilze-Rijen

Where nessecary a distinction was made between "local" bird strikes and strikes "en-route". The main criterium to assign the bird strikes to the appropiate category is speed in combination with altitude (ref.16). All strikes which took place at speeds lower than 300 kts and not exceeding a height of 500 ft were allocated to the group of local strikes. A small number of strikes cannot, on the base of this criterium, be said to be local or en-route and strictly speaking should be called "unknown". However, charactaristics of these strikes (% damage, distribution over the year, parts struck etc. etc.) give good cause to consider them as "en-route". So, all strikes that could not said to be "local" were assigned to the "en-route" group.

3. RESULTS

3.1. The number of Lapwings on RNLAF airfields.

For each airfield the mean pattern of presence of Lapwing through the year is given in figure 3. The area covered by the counts is roughly the same for all airfields. It is clearly shown that there are distinct differences between the airfields, both in absolute numbers and in the temporal pattern. Except for Eindhoven, where staging Lapwing during spring are mainly responsible for the high numbers, spring migration does not result in considerable numbers on RNLAF airfields. Instead, spring numbers more or less represent the arrival of the breeding populations of the airfields.

The influence of the surrounding landscape on Lapwing numbers is clearly shown in the case of Soesterberg. Although fully covered with grass, surrounding woods and urban areas transform the airfield into a relatively small secluded island of grass. Apperently this is not the kind a situation preferred by Lapwings.

It is not clear why summerpeaks of any significance are only registered on Leeuwarden and Eindhoven. The explanation might be found in the geographical location of these airfields in relation to the migration route of certain Lapwing populations.
Autumn migration does result in an increase in numbers on all airfields. However, there are considerable differences.

3.2. Lapwing strikes in the RNLAF.

Using ratio's (number of Lapwing strikes per 10,000 flying hours) comparison of Lapwing strikes through the years is possible. From 1960 onwards the ratio of RNLAF Lapwing strikes is given in figure 4.
The graph does show a pattern of ups and downs. More striking though is the general upward trend and especially the higher level since the mid seventies. To what extend this increase reflects an increase in Lapwing numbers is difficult to asses. Introduction of Bird Control Units in 1976 (ref.14) meant a better reporting standard. A better method of identification probably also is responsible for part of the increase. On the other hand, more scaring activity should have reduced the Lapwing numbers on the airfields. However, apart from the methodological biases there are indications that from a Lapwings point of view the attraction of the Netherlands as an area to stay after the breeding season did increase. This implies that despite all preventive efforts the increase of the strike ratio most probably is real.

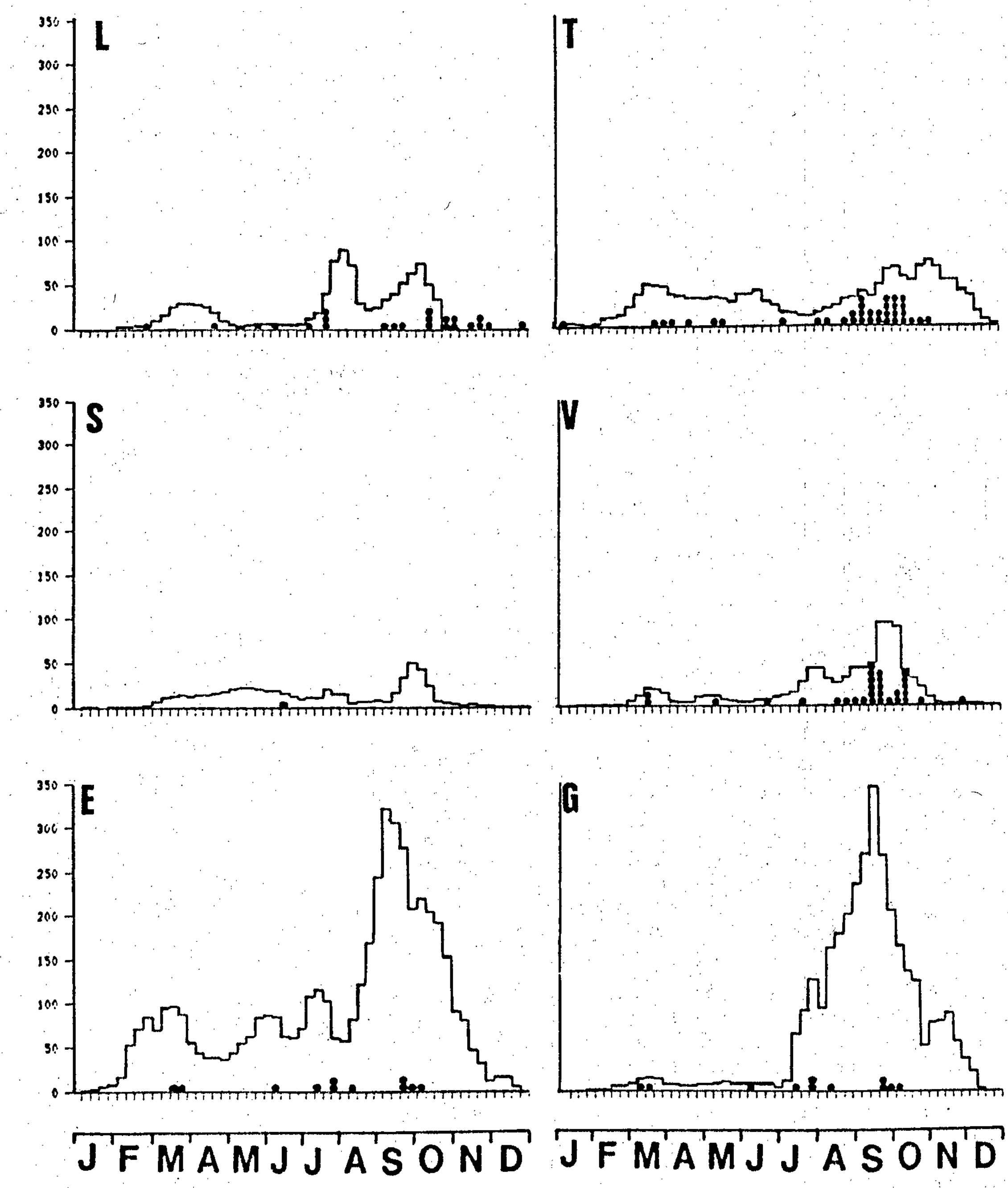

Figure 3: Running weekly mean number of Lapwings during the years 1982-1987 for 6 RNLAF airbases.
Local Lapwing sstrikes with RNLAF jets during the period 1960-1987 for each airbase are marked with dots.
For legenda of airbase names see fig.2.

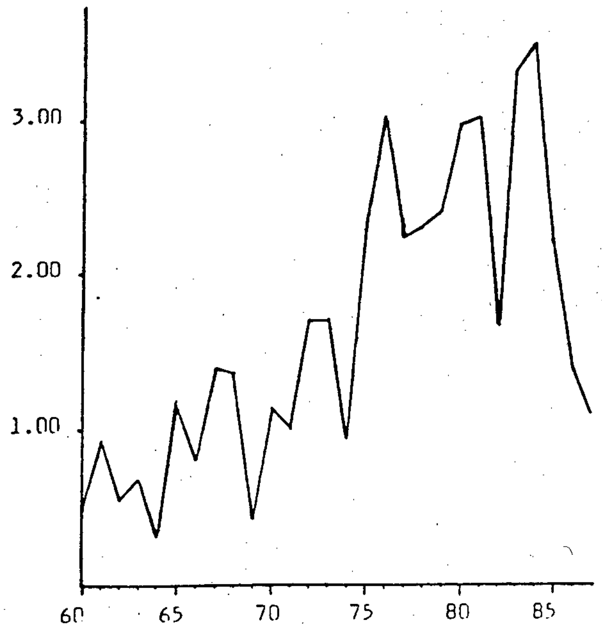

Figure 4:

Ratio of Lapwing strikes with RNLAF jets (per 10,000 flying hours) in the period 1960-1987.

The pattern of Lapwing strikes through the year is given in figure 5a. In order to interpret the three clear peaks in a justified way it is nessecary to make a distinction between "local" strikes and strikes that happened "en-route". Year patterns for local and for en-route Lapwing strikes are given in figures 5b and 5c.
It is now clear that the overall pattern of figure 5a is the result of two totally different patterns. Surprisingly, the autumn peak is dominated by strikes on and near the airfield while the spring and summer peak are mainly caused by "en-route" strikes. For the spring situation this can be explained by the altitude at which aircraft and Lapwings fly. Prevailing Southwesterly winds cause spring migration to take place at a higher altitude than in autumn. This means that in spring Lapwings and aircraft are competing for space in the same height band whilst in autumn the majority of migrating Lapwings fly at lower altitudes than aircraft en-route.

Because the situation with regard to bird strike prevention changed drastically thanks to the estabishment of bird control units in 1976, we splitted up our data in two periods, 1960-1976 and 1977-1987. The year pattern of local Lapwing strikes for both periods is given in figure 6. Although the percentage of Lapwing strikes from januari-june is decreased from 23% to 16% there does not seem to have changed much in the overall pattern of the local situation over the year. Over the 11 years between 1977 and 1987 the mean percentage of bird strikes with RNLAF jets which occurred on or near an airfield is 27% (SD=6). For Lapwing strikes this percentage is 59% (sd=12). So the Lapwing appears to be a species which specifically forms a problem an and near airfields and to a lesser extend "en-route".

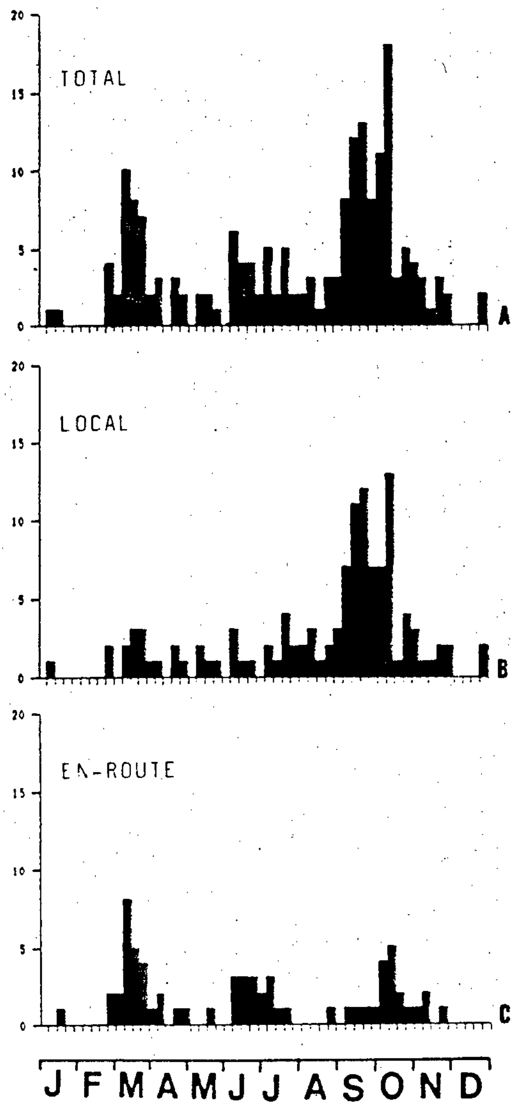

Figure 5:

Weekly distribution of Lapwing strikes in the RNLAF during the period 1960-1987.

a. top :all strikes n=183

b. middle :local strikes n=118

c. bottom :en-routestrikes n=65

However, this conclusion may overemphasize the danger of Lapwing on the airfield itself. If we exclude all "local" strikes (see 2.3.) above 100 ft. then the remaining total number of local strikes (marked black in fig.6) decreases with 20% in period I and with 40% in period II. This indicates that many strikes involve Lapwings <u>near</u> instead of <u>on</u> airfields, especially recently.

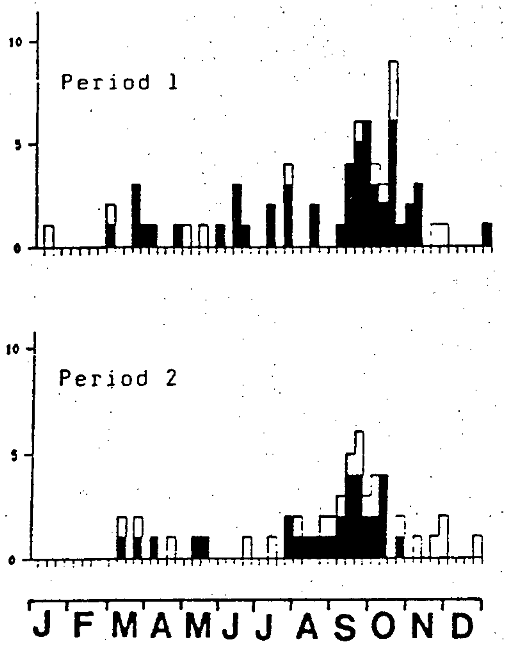

Figure 6:

Weekly distribution of local Lapwing strikes in the RNLAF during two periods.

a. period 1; 1960-1976
   n=66
b. period 2: 1977-1987
   n=52

Strikes that occured below 100 ft. are marked black.

3.3. Numbers of Lapwing versus Lapwing strikes.

Apart from the average pattern of Lapwing presence over the year, in figure 3 the distribution of Lapwing strikes over the year is visualized. Assuming that the pattern of Lapwing presence roughly will have been the same in the years previous to 1982, not only the local Lapwing strikes from 1982-1987 are marked but also the ones from previous years.

The figure indicates that, if there does exist a relation between numbers of Lapwing and Lapwing strike, this will certainly not be a simple one. Seasonal patterns of strikes do not always coincide with the distribution of Lapwing presence over the year.

For a more detailed analysis data from the years 1982-1987 were used. Using abundance classes for the Lapwing on 5 airfields, the frequency distribution is calculated for the weekly mean numbers of Lapwing per airfield and per year. For 18 Lapwing strikes during this period the accompanying mean number of Lapwings on that airfield and during that particular week were available; for those the frequency distribution over the same abunce classes was made. In figure 7 both frequency distributions are given. Although based on only 18 Lapwing strikes it is clear that two different situations do occur. As long as numbers of Lapwing stay below about 50, despite the high frequency of this situation, the chance for a strike to occur is relatively small. In the less frequent situations in which more Lapwings were present this chance is disproportionately high but not increasing when numbers grow even bigger.
Apperently, it is only to a certain extend that the number of Lapwing counted on the airfield determines the chance on a Lapwing strike.

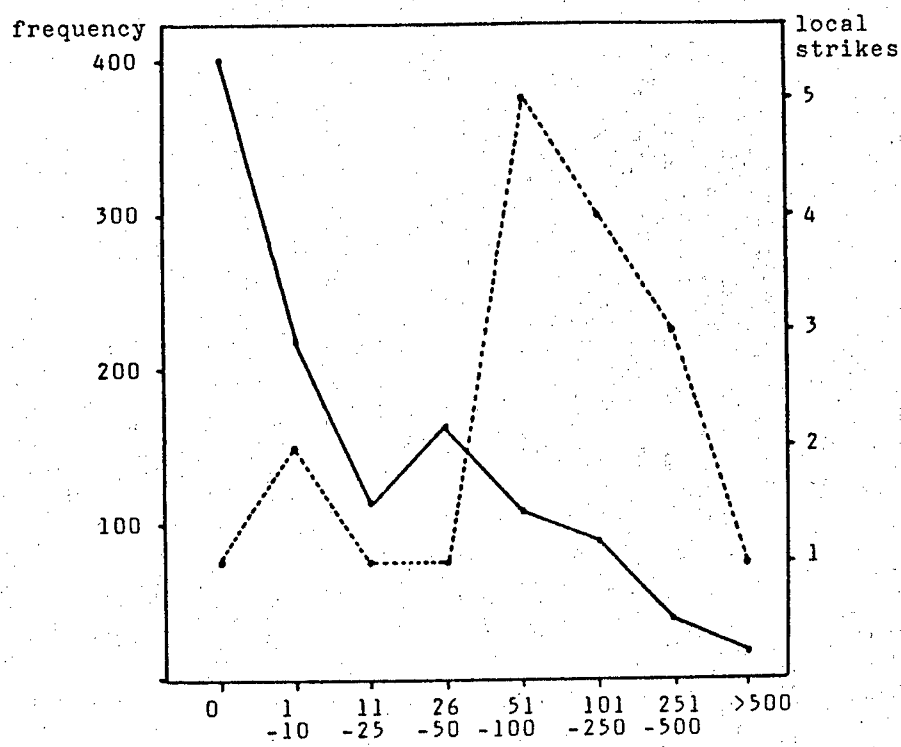

Figure 7: Frequency distribution of weekly mean numbers of Lapwing per airfield per year over 8 abundance classes. (solid line).
The number of local Lapwing strikes which coincided with each abundance class is represented with the dotted line.

4. DISCUSION.

Year patterns for different airfields at different locations, as are given in fig. 3, give a good idea about the different local situations. Nevertheless, these patterns may deviate considerable from the region wherein the airfield is situated. This means that evaluation of the registered numbers should be done in the perspective of the region the airfield is located in. To put it in an order way, we have to know how much is much.

Five years of field work, mainly carried out by amateurs and coordinated by full-time profesionnel ornithologists, have recently resulted in an Atlas of Dutch Birds in which quantitative information on the presence of birds per month is given (ref.10). Concentrating on autumn, fig. 8 shows the abundance of Lapwing per 5x5 km grid. It is clear that plots in which more than 1000 Lapwings occur are quite numerous and mainly do occur in all lower parts of the country. Assuming that a RNLAF-airfield on average covers about 300 to 400 Ha of open land this means that 150 Lapwings on a dutch airfield cannot be looked upon as excessive. On most airfields not even half of these numbers are registered, not even in peak times.

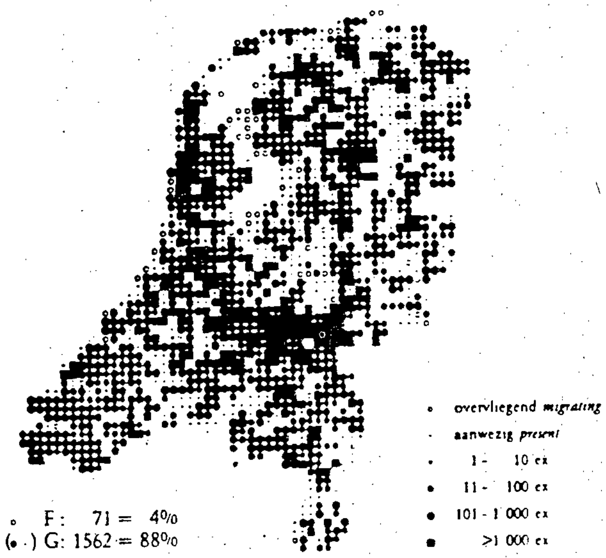

Figure 8: October distribution of the Lapwing in the Netherlands in a 5 x 5 Km. grid (from 10).

A number of factors possibly are responsible for these low numbers. First of all the good drainage of the most airfields in relation to the surrounding certainly does play a role. Furthermore, on Leeuwarden and Twenthe the agricultural management of the grassland is extensified and no longer aimed at production. This means that application of anorganic fertilizers -and as a consequence the number of agricultural actions- is brought back to a minimum level. Although not aimed at a certain grasslength this management implies that the grass is kept at a certain minimum height. Intensifying the effort of the Bird Control Unit in 1985, by increasing the manpower, also made a contribution. The combined effect is shown in the results of Twenthe airbase. The overall picture from figure 3 over the years 1982-1987 hides the differences between the consecutive years. For 1983-1987 the seperate patterns are shown in figure 9, (1982 was left out because of insufficient data). It is clearly shown that more attention to a bird-unfriendly management did pay off in the sense that the numbers of Lapwing drastically decreased. This decrease was not a simple result of a lower number of Lapwings per sighting. As is shown in figure 10, the main way in which numbers decreased was by the absence of big flocks of over a hundred Lapwings and by the nearly complete absence of Lapwings during the second half of autumn.

That there is always an other side of the coin is also demonstrated in figure 9; coinciding with the decrease of the Lapwing the Kestrel (Falco tinnunculus) considerably increased in numbers. A more numerous rodent population (mice/voles) as a concequence of the extensified agricultural management is responsible for this increase.

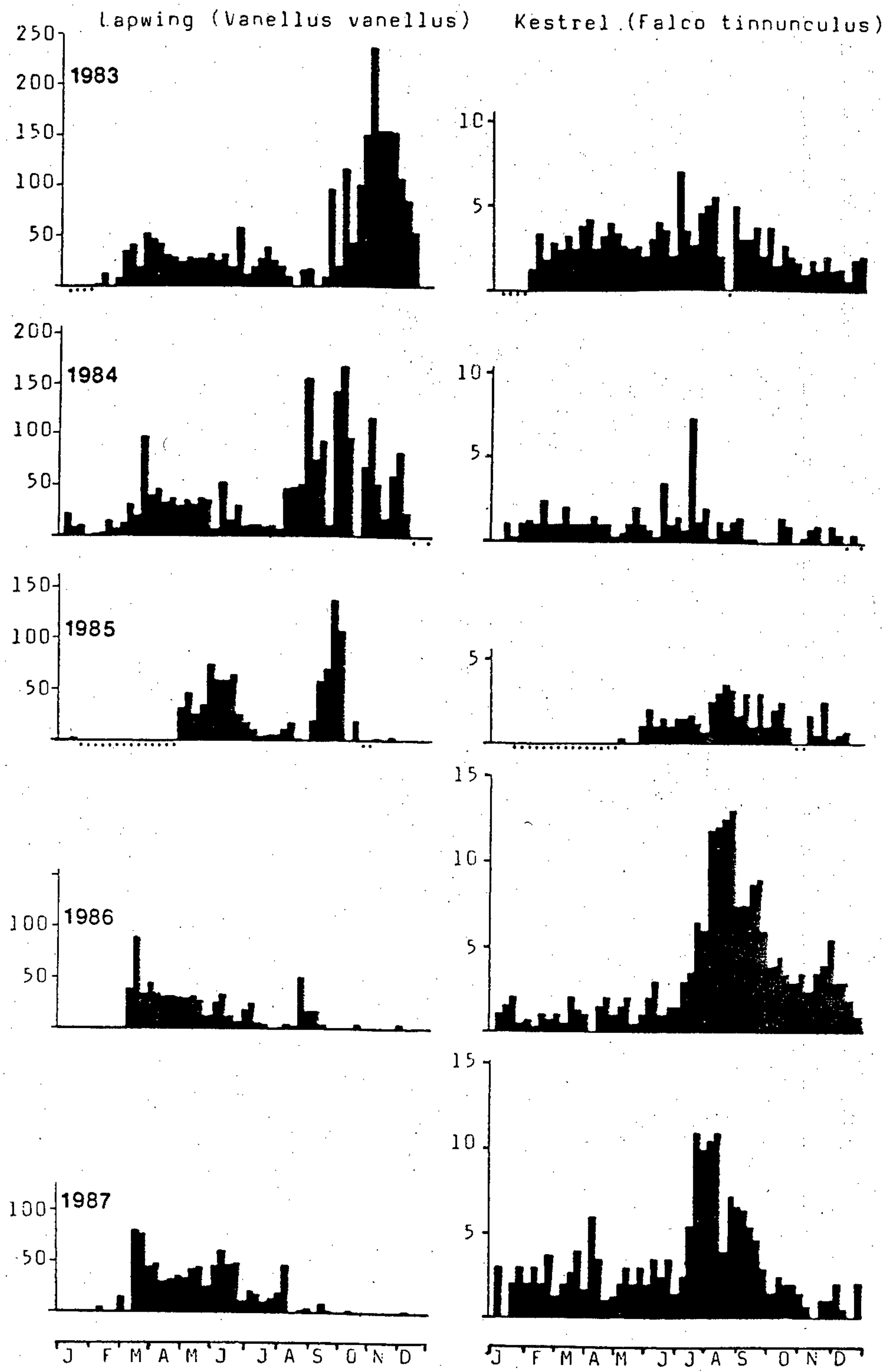

Figure 9: Weekly mean numbers on Twenthe airbase during the years 1983-1987 of Lapwing (left) and Kestrel (right). Weeks lacking any data are marked with a dot.

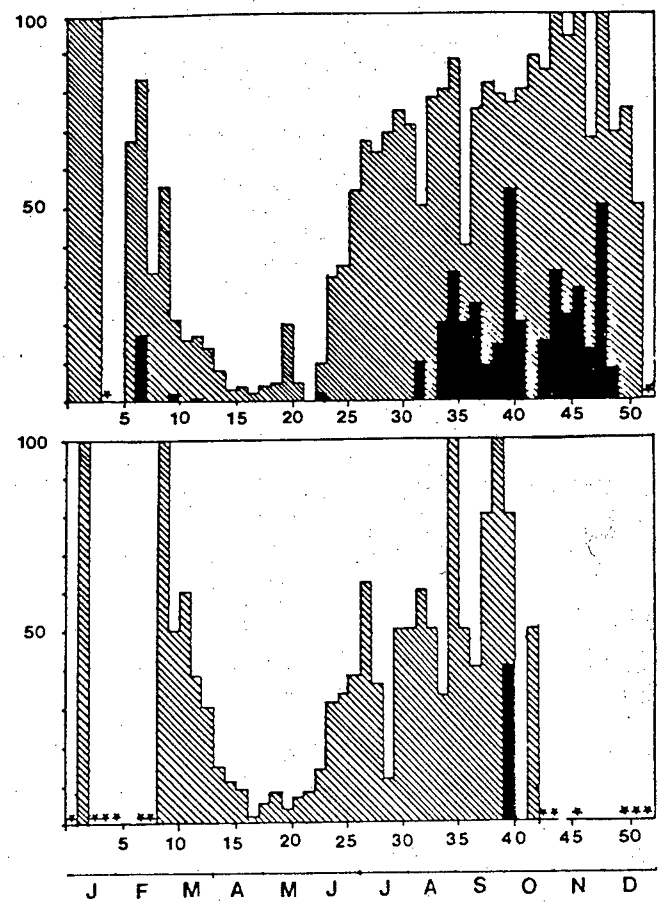

Figure 10: Weekly percentual distribution of Lapwing sightings on Twenthe airbase over the following number categories: 1-9 ex. (white)
10-99 ex. (shaded)
> 100 ex. (black)
Weeks without any Lapwing sightings are marked with an asterix.
Top : 1982-1984 N= 1141
Bottom : 1985-1987 N= 605

Besides the agricultural management, on Eindhoven airbase infrastructure changed drastically during the last years, works involved the relocation of the runway. As a result the numbers in autumn rose considerable and do not represent the present situation any more. Although the pattern of presence essentially stayed the same during all six years, the general level in the last two years has decreased.

In general, wintering numbers of Lapwings in the Netherlands probably have increased. However, the numbers on most RNLAF airfields do show a downward trend over the last years. This in the first place is the effect of measures taken by the RNLAF, but changing habits of Lapwing might have been helpful as well. There are indications that the presence of Lapwing is less confined to grassland areas and that arable land in later years does hold considerable numbers. Furthermore, as a concequence of intensive agricultural techniques dutch agricultural lands are more productive than ever. For some species, e.g. gulls, crows, geese, duck and probably Lapwings as well, this means that these lush and rich fields became more attractive than ever. This might have led to a change in migrating behaviour of the Lapwing in the sense that more and more Lapwing are reluctant to leave the Netherlands for their ultimate wintering areas in SW France, Iberia and the UK and do not leave the country before frost and/or snow forces them, but accumulate in the western most part of the country. Counts on Schiphol airport do support this phenomenom. During the late seventies october/november numbers averaged around 560 while an average of 3393 is scored during the years 1984-1986 (ref.17). In this respect the westerly location of Gilze-Rijen airbase may well be one of the factors responsible for the relatively high autumn numbers of Lapwing there.

At first sight the poor relation between Lapwing strikes and the number of local Lapwings present is rather surprising. In order to understand this we have to realise that, in order for a strike to occur both aircraft and birds have to be flying. In other words aircraft don't hit birds that stay on the ground. The potential riskfull situations then, are those which involve a high number of flying activity of Lapwings. Local movements which are not necessarily related to the number of Lapwing on the airfield can be one cause (e.g. flights between roost and foraging grounds). Disturbance on the airfield of big flocks may form an other source of an excessive flying movements. Furthermore, in certain weather conditions migration sometimes takes place in high densities at such low altitudes that interference with local aircraft movement is unavoidable.

We conclude that two prevention methods could help reduce Lapwing strikes and are feasable on short term.

a.) avoiding the establishment of big (roosting) flocks on the airfield;

b.) assessing the predictability of the variation and patterns of local flights and/or monitor these movements ad hoc and adapting the flightprogram.

Long term measures such as inf[illegible] the local flight pattern of Lapwings by changing crucial [illegible] of the Lapwing habitat outside the airfield usually will meet strong opposition of the public and effects are difficult to achieve. The intensity of movements of the total local bird population may in certain cases even be a consideration in the (re)allocation of an airfield.

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ADF616025

Management of a birdstrike data base using an IMB-PC Compatible microcomputer

(Alain Eudot, France)

BSCE 19/ WP 28

Madrid, 23-28 May 1988

Management of a birdstrike data base using an IBM-PC compatible microcomputer

PICA: A birdstrike information program

(Alain EUDOT. Service Technique de la Navigation Aérienne FRANCE)

ABSTRACT

Data processing of birdstrikes with an IBM-PC compatible microcomputer gives quick collation of statistics on the basis of a large number of factors (bird species, aircraft types, etc.).
The program described was developed with a conventional package (dBase III Plus) and can be adapted to data from any country provided that it is translated first.

I Presentation of the program

The birdstrike data program (PICA) was developed on an IBM-PC compatible microcomputer. It is used to process birdstrike data at a national level.

II Reasons

The main reason is to offer the user an easy to use product allowing real time retrieval of data from a database on birdstrikes which have occurred in the user's own country, or abroad, with national airlines. The version presented here is the French version of the PICA program, although prior translation of the texts would enable it to be adapted to the requirements of any user.

II.1 Portability of the program

PICA is developed on an IBM-PC compatible microcomputer on the basis of a common package: dBase III plus. PICA can then be compiled and this compilation ensures the portability of the program on any compatible microcomputer.

II.2 Facilities

The user-friendliness of the program has been particularly closely studied. As soon as the program is started, the main menu appears and leads the user through a number of choices with a series of consecutive menus.

II.3 Availability

For the user, the possibility of real time access to birdstrike data is of undeniable interest.

Providing an answer to the operator wanting a list of the birdstrikes involving its airline on a given airport, or the distribution of birdstrikes per runway on a given airport, is now simple and the reply is immediately available.

II.4 "Cleanness" of the file

One of the advantages of microcomputers is that a large amount of data can be stored in a small space. The capacity of the computer used means that for a country like France, which records about 400 birdstrikes per year, data can be stored for a hundred years of civil aviation. The birdstrike reports received from the airfields, crews or maintenance shops are checked, encoded and entered into the computer as and when they arrive. They are then only used for entry of data.

II.5 Presentation of results

The results are output in the form of complete forms, tables or graphs, which can be directly used to illustrate study reports.

II.6 Open-ended program

The structure of the PICA program and the databases it generates is not fixed. All changes are possible and the user's additional needs can be integrated at any time.

This can concern either the processing of the data, or the content of the data (additional headings on the birdstrike report form).

III Description of the hardware used

III.1 Hardware

The IBM-PC compatible microcomputer on which the PICA was developed is an OLIVETTI/PC/M240, with the following main characteristics:

CPU:	8086 (1 MHz)
ROM memory:	32 K
RAM memory:	640 K
Floppy disk drive:	5.25" - 360 K
Hard disk drive:	3.5" - 20 Mb (85 msec)
Power supply:	220 V (± 10%) - 50 Hz
Consumption:	183 W
Video controller:	OGC
Interfaces:	Parallel (CENTRONICS) Serial (RS.232.C)
Extension connector:	7 8-bit connectors.

III.2 Software

The PICA program is an application developed from a conventional, commonly available package: dBase III Plus produced by ASHTON-TATE.

A utility, dBase TOOLS for C.graphics library, produced by the same company, was used to develop the graphic editor programs.

IV PICA program

IV.1 Main menu

The PICA program is entered via the main menu (Figure 1) which sends the user on to a series of other menus. These then guide the user throughout the processing session.

It is only possible to terminate processing from the main menu.

```
PROGRAMME "PICA"      . STNA/2N

1 . Gestion Base de Données COLLISIONS OISEAUX-AERONEFS
2 .                         OISEAUX
3 .                         AVIONS
4 .                         MOTEURS
5 .                         COMPAGNIES
6 .                         AERODROMES FRANCAIS
7 .                         AERODROMES ETRANGERS
8 .                         SOURCE DES INFORMATIONS
9 . MISE A JOUR DES DIFFERENTES BASES DE DONNEES

VOTRE CHOIX :          Frapper 0 pour quitter le programme PICA
```

Figure 1.

IV.2 Birdstrike database management

Choice number 1 proposes birdstrike database management. This is the main reason behind the PICA program. The menus to which it refers are examined in chapter IV.5.

IV.3 Management of BIRDS. AIRCRAFT. ENGINES. AIRLINES. FRENCH and FOREIGN AIRFIELDS. INFORMATION SOURCE databases

These various databases were created to speed up the processing time required for the various editing operations proposed in birdstrike database management. They can also be used to give a summary of birdstrikes since 1974 for a given criterion. Their menu (Figure 2) proposes either data entry or data modification. When these operations are completed, the user returns to the main menu by choosing the "End session" option. The number of strikes is not entered manually, but calculated by the computer from the birdstrike database.

Gestion de la base de données MOTEURS . STNA/2N
1 . Saisie des données 2 . Modification des données

VOTRE CHOIX :	Frappez 0 pour la fin de session

Figure 2.

When data is entered (or modified), the computer asks the operator for confirmation.

If this is not given (data incorrect), control is returned to the operator for the appropriate correction.

If it is, the data are recorded and the computer then asks the operator whether he intends to continue entry (or modification):

- if yes, a new entry (or modification) screen is displayed.

- if no, the database management menu reappears.

IV.3.1 BIRDS database (Figure 3)

Code STNA	:MOUET.RI
Code IBIS	:NE136
Nom commun	:MOUETTE RIEUSE
Nom latin	:LARUS RIDIBUNDUS
Poids	: 300
Catégorie	:B

NOMBRE DE COLLISIONS EN METROPOLE

1974	:	1985	:
1975	:	1986	:
1976	:	1987	: 86
1977	:	1988	:
1978	:	1989	:
1979	:	1990	:
1980	:	1991	:
1981	:	1992	:
1982	:	1993	:
1983	:	1994	:
1984	:	1995	:

ETRANGER + DOM-TOM

1974	:	1985	:
1975	:	1986	:
1976	:	1987	: 6
1977	:	1988	:
1978	:	1989	:
1979	:	1990	:
1980	:	1991	:
1981	:	1992	:
1982	:	1993	:
1983	:	1994	:
1984	:	1995	:

Figure 3.

For a given bird species, this gives the number of strikes per year in mainland FRANCE or abroad, for French airlines, as well as in the overseas territories. The species is described by its STNA code, its IBIS code, its common and scientific names, its weight and its category (A,B,C,D).

IV.3.2 AIRCRAFT database (Figure 4)

Code STNA : EA30
Code IBIS : 04101
Propulsion : REACTEUR

VOUS DEVEZ TAVERSER TOUS LES CHAMPS POUR QUE VOTRE CORRECTI
SOIT PRISE EN COMPTE.
FRAPPEZ 'ECHAP 'POUR INTERROMP
LA MODIFICATION.

1:METROPOLE
2:ETRANGER+DOM-TOM
3:AF+IT+UT

NOMBRE DE COLLISIONS

		1	2	3			1	2	3
1974	:	0	0	0	1985	:	0	0	0
1975	:	0	0	0	1986	:	0	0	0
1976	:	0	0	0	1987	:	119	13	134
1977	:	0	0	0	1988	:	0	0	0
1978	:	0	0	0	1989	:	0	0	0
1979	:	0	0	0	1990	:	0	0	0
1980	:	0	0	0	1991	:	0	0	0
1981	:	0	0	0	1992	:	0	0	0
1982	:	0	0	0	1993	:	0	0	0
1983	:	0	0	0	1994	:	0	0	0
1984	:	0	0	0	1995	:	0	0	0

NOMBRE DE MOUVEMENTS AF,IT,UT

1974	:	0	1985	:	0
1975	:	0	1986	:	0
1976	:	0	1987	:	0
1977	:	0	1988	:	0
1978	:	0	1989	:	0
1979	:	0	1990	:	0
1980	:	0	1991	:	0
1981	:	0	1992	:	0
1982	:	0	1993	:	0
1983	:	0	1994	:	0
1984	:	0	1995	:	0

Figure 4.

For a given type of aircraft, this gives the number of strikes per year in mainland FRANCE or abroad and in the overseas territories for French airlines, as well as for AIR FRANCE, AIR INTER and UTA (leading French airlines).

The operator enters the number of movements per type of aircraft for these three companies taken together, which allows calculation of the birdstrike rate per 10,000 movements for this type of aircraft.

The aircraft is described by its ICAO (STNA) code, its IBIS code and its means of propulsion.

IV.3.3 <u>ENGINES database</u> (Figure 5)

```
Code STNA : CF6.50C2R
Code IBIS : 2207
Famille   : CF6
```

NOMBRE DE COLLISIONS EN METROPOLE

1974 :	0	1985 :	0
1975 :	0	1986 :	0
1976 :	0	1987 :	119
1977 :	0	1988 :	0
1978 :	0	1989 :	0
1979 :	0	1990 :	0
1980 :	0	1991 :	0
1981 :	0	1992 :	0
1982 :	0	1993 :	0
1983 :	0	1994 :	0
1984 :	0	1995 :	0

ETRANGER+DOM-TOM

1974 :	0	1985 :	0
1975 :	0	1986 :	0
1976 :	0	1987 :	18
1977 :	0	1988 :	0
1978 :	0	1989 :	0
1979 :	0	1990 :	0
1980 :	0	1991 :	0
1981 :	0	1992 :	0
1982 :	0	1993 :	0
1983 :	0	1994 :	0
1984 :	0	1995 :	0

Votre modification est-elle correcte ? (O/N) : O
Voulez-vous continuer à modifier des données ? (O/N) :

Figure 5.

For a given type of engine, this gives the number of strikes per year in mainland FRANCE or abroad and in the overseas territories for French airlines.

The engine is described by its ICAO (STNA) code, its IBIS code and its family.

IV.3.4 <u>AIRLINES database</u> (Figure 6)

```
Code OACI   :AF     Nationalité (F/E): F
Compagnie   :AIR FRANCE
```

NOMBRE DE COLLISIONS
METROPOLE ETRANGER + DOM-TOM

1974 :	1985 :	
1975 :	1986 :	
1976 :	1987 :	51 44
1977 :	1988 :	
1978 :	1989 :	
1979 :	1990 :	
1980 :	1991 :	
1981 :	1992 :	
1982 :	1993 :	
1983 :	1994 :	
1984 :	1995 :	1

NOMBRE DE MOUVEMENTS

1974	:	1985	:
1975	:	1986	:
1976	:	1987	: 236364
1977	:	1988	:
1978	:	1989	:
1979	:	1990	:
1980	:	1991	:
1981	:	1992	:
1982	:	1993	:
1983	:	1994	:
1984	:	1995	:

Votre modification est-elle correcte ? (O/N) : O
Voulez-vous continuer à modifier des données ? (O/N) :

For a given airline, this gives the number of strikes per year in mainland FRANCE or abroad for the French airlines, as well as in the overseas territories.

The operator enters the number of movements per airline, which is described by its ICAO code, its nationality (French or foreign) and its commercial name.

IV.3.5 FRENCH AIRFIELDS database (Figure 7)

Code OACI : LFPO
Aérodrome : PARIS-ORLY

NOMBRE DE MOUVEMENTS COMMERCIAUX

1974 :	0	1985 :	0
1975 :	0	1986 :	0
1976 :	0	1987 :	625000
1977 :	0	1988 :	0
1978 :	0	1989 :	0
1979 :	0	1990 :	0
1980 :	0	1991 :	0
1981 :	0	1992 :	0
1982 :	0	1993 :	0
1983 :	0	1994 :	0
1984 :	0	1995 :	0

ON — NEAR

1974 :	0	01985 :	0	0
1975 :	0	01986 :	0	0
1976 :	0	01987 :	42	1
1977 :	0	01988 :	0	0
1978 :	0	01989 :	0	0
1979 :	0	01990 :	0	0
1980 :	0	01991 :	0	0
1981 :	0	01992 :	0	0
1982 :	0	01993 :	0	0
1983 :	0	01994 :	0	0
1984 :	0	01995 :	0	0

1974:	1976:	1978:	1980:	1982:	1984:	1986:	1988:	1990:	1992:	1994:
1975:	1977:	1979:	1981:	1983:	1985:	1987:	01989:	1991:	1993:	1995:

— AVIATION NON COMMERCIALE

Figure 7.

For a given airfield, this gives the number of "commercial" birdstrikes on and near the airfield, on the basis of the criteria adopted by the ICAO, as well as the number of strikes concerning non-commercial aviation.

The user enters the number of commercial movements per airfield.

The airfield is described by its ICAO code and its name.

IV.3.6 FOREIGN AIRFIELDS database (Figure 8)

For a given airfield, this gives the number of strikes on and near the airfield.

The airfield is described by its ICAO code and its name.

code OACI : DAAG
Aérodrome :ALGER-HOUARI BOUMEDIENE

NOMBRE DE COLLISIONS SUR L'AERODROME

1974	: 0	1985	: 0
1975	: 0	1986	: 0
1976	: 0	1987	: 3
1977	: 0	1988	: 0
1978	: 0	1989	: 0
1979	: 0	1990	: 0
1980	: 0	1991	: 0
1981	: 0	1992	: 0
1982	: 0	1993	: 0
1983	: 0	1994	: 0
1984	: 0	1995	: 0

COLLISIONS PRES DE L'AERODROME

1974	: 0	1985	: 0
1975	: 0	1986	: 0
1976	: 0	1987	: 0
1977	: 0	1988	: 0
1978	: 0	1989	: 0
1979	: 0	1990	: 0
1980	: 0	1991	: 0
1981	: 0	1992	: 0
1982	: 0	1993	: 0
1983	: 0	1994	: 0
1984	: 0	1995	: 0

FRAPPEZ 'ECHAP' POUR INTERROMPRE LA CORRECTION

Votre modification est-elle correcte ? (O/N) : O
Voulez-vous continuer à modifier des données ? (O/N) :

Figure 8.

IV.3.7 INFORMATION SOURCE database (Figure 9)

Source de l'information:TER
DM,TER,PIL,DM+TER,DM+PIL,TER+PIL,DM+TER+PIL

NOMBRE DE COLLISIONS

1974	: 0	1985	: 0
1975	: 0	1986	: 0
1976	: 0	1987	: 98
1977	: 0	1988	: 1
1978	: 0	1989	: 0
1979	: 0	1990	: 0
1980	: 0	1991	: 0
1981	: 0	1992	: 0
1982	: 0	1993	: 0
1983	: 0	1994	: 0
1984	: 0	1995	: 1

FRAPPEZ 'ECHAP' POUR INTERROMPRE LA CORRECTION

Votre modification est-elle correcte ? (O/N) : O
Voulez-vous continuer à modifier des données ? (O/N) :

Figure 9.

The various sources of information are:

- the airfield (TER)
- the aircrews (PIL)
- the maintenance shops (DM)

The information can therefore come from one of the above sources, or from several of them.

This database gives the number of strikes declared by one of these sources, or a combination thereof.

IV.4 Updating the databases (Figure 10)

The various databases described in the previous chapter should be updated for a given year whenever new information is added to them.

This is the aim of option number 9 on the main menu.

PROGRAMME DE MISE A JOUR DES BASE DE DONNEES . STNA/2N

1 . Mise à jour Base de Données	OISEAUX
2 .	AVIONS
3 .	MOTEURS
4 .	COMPAGNIES
5 .	AERODROMES FRANCAIS
6 .	AERODROMES ETRANGERS
7 .	SOURCE DES INFORMATIONS

VOTRE CHOIX :	Frapper 0 pour retour au menu précédent

Programme de mise à jour de la base de données OISEAUX . STNA/2N

1 . 1974	7 . 1980	13 . 1986	19 . 1992
2 . 1975	8 . 1981	14 . 1987	20 . 1993
3 . 1976	9 . 1982	15 . 1988	21 . 1994
4 . 1977	10 . 1983	16 . 1989	22 . 1995
5 . 1978	11 . 1984	17 . 1990	
6 . 1979	12 . 1985	18 . 1991	

VOTRE CHOIX :	Frapper 0 pour retourner au menu précèdent

Figure 10.

The user chooses the database he wishes to update and then the year in question.

Updating takes a relatively long time and the computer will need about 2 minutes to do this.

IV.5 Birdstrike database management

After starting the PICA program, the user chooses option number 1: birdstrike database management. A first screen (Figure 11) appears and asks the operator which year he wishes to work on.

```
Gestion de la base de données COLLISIONS OISEAUX-AERONEFS . STNA/2N

        Choisissez l'année sur laquelle vous voulez
        travailler . Si vous avez choisi une année
        dont le fichier n'existe pas , le curseur
        vous est rendu : faites un autre choix...

ANNEE :                    Frappez 0 pour revenir au menu principal
```

Figure 11.

PICA is designed so that there is not just one database containing all the birdstrikes, but one for each year.

The advantage of this breakdown is to minimize the calculation time needed to edit data which are not directly available in the various databases presented in chapter IV.3.

The menu in Figure 12 is then proposes.

```
Gestion de la base de données COLLISIONS OISEAUX-AERONEFS . STNA/2N

            1 . Saisie des données
            2 . Modification des données
            3 . Tris
            4 . Destruction d'une fiche
            5 . Edition

VOTRE CHOIX :              Frappez 0 pour la fin de session
```

Figure 12.

IV.5.1 Data entry

The data entry screen (Figure 13) for birdstrikes proposes all the headings in the birdstrike report form (specimen of form No. 1 published in DOC 9332-AN / 909 from the ICAO) and four additional headings:

- Delay (Y/N): Operating delay (yes or no).

- Fan blades U/S: Number of fan blades unserviceable.

- Spiral (Y/N): presence of an "eyeball" on the engine nosecone (yes or no).

- Information source: airfield, aircrew or maintenance shop.

```
         ECRAN DE SAISIE DES COLLISIONS OISEAUX-AERONEFS
+--------------------------------------------------------------------------+
|Exploitant :          Aéronef :        Moteur :             Immat :       |
|Date       :   /  /    Heure :         Eclairement :                      |
|Aérodrome  :           Piste :                                            |
+--------------------------------------------------------------------------+

+--------------------------------------------------------------------------+
|Hauteur      :         Vitesse :       Phase de vol          :            |
|Phares d'atterrissage (O/N) :          Feux à éclats (O/N)   :            |
|VMC/IMC (V/I) :        Nuages  :       Précipitations        :            |
|Espèce ornithologique :              Aperçus :  Touchés :  Taille :       |
+--------------------------------------------------------------------------+

+--------------------------------------------------------------------------+
|DEGATS : Radome  Pare-brise  Nez     Mot1  Mot2  Mot3  Mot4               |
|(M/L/G)                                                                   |
|         Hélice     Aile   Fuselage   Train  Empennage  Feux               |
|                                                                          |
+--------------------------------------------------------------------------+
Effet        :          Coût   :               Pilote averti (O/N) :
Observations            :
Retard (O/N)  :  Aubes de fan HS :   Spirale (O/N) :   Information :
                                                       (DM,TER,PIL)

Votre saisie est-elle correcte ? (O/N): O
VOULEZ-VOUS CONTINUER ? (O/N): N
```

Figure 13.

The user moves the cursor over the screen from heading to heading, following the arrows on the computer keyboard, and enters the data in his possession.

It is possible to return to a heading at any time if its content is incorrect.

When data entry of a form is completed, the computer asks the operator if it is correct. If an error is detected, the operator replies "No" (N): the form stays on the screen and the operator can make the correction by placing the cursor on the heading to be modified.

The computer then asks the operator if he wishes to continue data entry:

- if yes, a new entry screen appears,

- if no, the menu in figure 11 is displayed.

IV.5.2 Data modification

The operator is asked to enter the date and time of the record to be modified (Figure 14).

```
ENREGISTREMENT A MODIFIER
Date :   /  /     Heure :
```

Figure 14.

If this does not exist, an error message is displayed and the menu in Figure 11 reappears.

If there are several records with the same date and time, a form appears on the screen (Figure 15).

- If it is the form to be modified, the operator makes the correction. In the same way as with data entry, the computer requests confirmation.

- If it is not the form to be modified, the operator can find the right one with the page up or page down keys on the keyboard.

```
ECRAN DE MODIFICATION DES COLLISIONS OISEAUX-AERONEFS

Exploitant :          Aéronef :          Moteur :              Immat :
Date       :   /  /    Heure :           Eclairement :
Aérodrome  :           Piste :

Hauteur    :          Vitesse :          Phase de vol             :
Phares d'atterrissage (O/N) :            Feux à éclats (O/N)      :
VMC/IMC (V/I) :       Nuages   :         Précipitations           :
Espèce ornithologique :               Aperçus :   Touchés :    Taille :

DEGATS : Radome  Pare-brise  Nez      Mot1  Mot2  Mot3  Mot4
(N/L/G)
         Hélice      Aile  Fuselage   Train  Empennage  Feux

Effet     : AUCUN    Coût  :              Pilote averti (O/N) :
Observations         :
FRAPPER 'ECHAP' POUR INTERROMPRE LA MODIFICATION
Votre modification est-elle correcte ? (O/N) :
```

FIGURE 15.

IV.5.3 Sort

Selecting the Sort option will send the operator to a sub-menu (Figure 16).

```
Gestion de la base de données COLLISIONS OISEAUX-AERONEFS . STNA/2N
                      PROGRAMME DE TRIS

            1.Sélectionner les critères
            2.Editer les tris

VOTRE CHOIX :            Frappez 0 pour retour au menu précédent
```

Figure 16.

IV.5.3.1 Criterion selector

The operator first of all gives a name to the "sort" file, also called extraction file, he wishes to create. For example, if he wishes to sort the birdstrikes affecting AIR FRANCE for the PARIS - CHARLES DE GAULLE airport in 1987, he could call the file: LFPGAF87.

A screen then appears, on which the operator will specify the sorting criteria (Figure 17):

```
:réer le filtre        Emboîtement        Affichage        Sortie  07:4

Nom du champ           EXP
Opérateur              Egal à
Constante/Expres.      "AF"
Connexion               .AND.

Numéro de ligne        1
```

Ligne	Champ	Operateur	Constante/Expression	Connexion
1	EXP	Egal à	"AF"	.AND.
2	LIE	Egal à	"LFPG"	
3				
4				
5				
6				
7				

```
:EATE QUERY    <C:> LFPGAF87.QRY         Opt: 4/5                M
     Sélection: ┘        Quitter menu:
       Spécifie une connexion logique pour poser la condition du filtre
```

Figure 17.

- the name of the heading on which he wishes the sorting to be done,
  e.g.: EXP (for airline).

- an operator
  e.g.: equal to

- a constant
  e.g.: 'AF'

- a connection
  e.g.: combined with AND

And then:

- the name of the new heading
  e.g.: LIE (for site/airfield)

- an operator
  e.g.: equal to

- a constant
  e.g.: 'LFPG'

- a connection
  e.g.: end of combinations.

With the choice of sorting criteria now completed, the file created should be saved by the quit-save option on the screen.

IV.5.3.2 <u>Sorting output</u>

Once the file has been saved, the menu in Figure 16 reappears. The operator can then choose to output the sorted data (appendix 1) or any other extraction file already created.

IV.5.4 <u>Deleting a file</u>

The operator may need to delete a birdstrike report form. To do this, he must specify the date, time and place of the record he wishes to delete (Figure 18).

```
ENREGISTREMENT A DETRUIRE
Date :    /  /     Heure :          Lieu :
```

```
Pour qu'une fiche puisse être détruite,vous
devez obligatoirement entrer les données demandées
```

Figure 18.

This then appears on the screen and the operator either confirms deletion or not.

As with modification, if the form requested does not exist, the menu in Figure 11 reappears.

If the date, time and place criteria correspond to more than one record, the operator can consult them with the page up and page down keys on the keyboard and select that which is to be deleted.

IV.5.5 Data output

Choosing the Output option, sends the operator to a sub-menu (Figure 19).

```
Gestion de la base de données COLLISIONS OISEAUX-AERONEFS . STNA/2N

          1 . Edition de l'année complète
          2 . Edition d'une période donnée
          3 . Edition de tableaux
          4 . Edition de graphes
          5 . Edition d'histogrammes
          6 . Edition BSCE
          7 . Edition IBIS

VOTRE CHOIX :            Frappez 0 pour retour au menu précédent
```

Figure 19.

IV.5.5.1 Output for a complete year

All the birdstrikes for the year in question will be printed out in the shape of forms identical to those presented in appendix 2.

IV.5.5.2 Output for a given period

The operator chooses a start and end date for the period (Figure 20). Only those birdstrikes which occurred during this period will be printed out (example in appendix 2).

```
Vous devez entrer la date sous la forme : 01/01/87

   DATE DE DEBUT                DATE DE FIN
   DE    PERIODE                DE  PERIODE
   03/05/87                       /  /
```

Figure 20.

IV.5.5.3 Printing out tables

A sub-menu appears (Figure 21) which gives the operator the choice between several tables which can be either called up on the screen or output on the printer.

GESTION DU FICHIER OISEAU . STNA/2N

1	TAB1	:	Source des informations sur les collisions
2	TAB2	:	Répartition des incidents par aérodrome
3	TAB3	:	Taux annuel de rencontres d'oiseaux par aérodrome
4	TAB4	:	Nombre d'incidents sur les aérodromes étrangers
5	TAB5	:	Distribution mensuelle des collisions par espèce d'oiseau
6	TAB6	:	Espèces d'oiseaux rencontrées
7	TAB7	:	Taux de rencontres d'oiseaux par type d'appareil
8	TAB8	:	Incidents par type de moteurs
9	TAB9	:	Incidents par compagnie
10	TAB10	:	Localisation des impacts
11	TAB11	:	Dommages subis
12	TAB12	:	Incidents pour la compagnie AIR INTER
13	TAB13	:	Conséquences sur le vol
14	TAB14	:	Incidents par phase de vol

VOTRE CHOIX :

Frapper 0 pour retourner au menu précédent

Figure 21.

A few examples of these tables are given in appendix 3.

Note: these examples are not always complete with regard to the birdstrike rates per 10,000 aircraft movements, since the number of movements for 1987 is not yet available. The few data given in the various tables concerning the number of movements are therefore dummy data intended to illustrate the principles laid down in this text. In addition, those tables giving a trend over several years only contain the results for 1987, since the data for the previous years have not yet been entered.

IV.5.5.4 Printing out graphs and histograms

A histogram can be output for a particular airfield, giving the trend over 11 years for the number of birdstrikes according to given criteria (Figure 22).

Histogram examples are given in appendix 4. Graphs and histograms can thus be either output on the screen, or printed out on the printer, for an airline, aircraft type, etc.

```
Pour quel aérodrome voulez-vous éditer le graphe : LFPO
Depuis quelle année                              : 1980

choisissez les données que vous voulez voir apparaitre sur le graphe
```

1-Pistes	2-Espèces d'oiseaux	3-Saisons	4-Heures

Votre choix : 2	Frapper 0 pour retour au menu précédent

```
Vous aller choisir les espèces pour lesquelles vous
voulez connaitre le nombre de collisions.(3 maximum)
Entrez le code STNA de l'espèce choisie (ex:VANO.HUP)

            Première espèce  : VANO.HUP
            Seconde espèce   : MOUET.RI
            Troisième espèce: PIGEON.D
```

Figure 22.

IV.5.5.5 BSCE output

The various tables supplied yearly to the ANALYSIS working group of the BSCE can be output directly as proposed in appendix 5.

IV.5.5.6 IBIS output

The IBIS code transcription of the birdstrike form for the year in question can be done automatically and output in the form presented in appendix 6.

APPENDIX 1

DATE	LIEU	AVION	CIE	HAUT	VOL	OISEAU	VUS	PARTIE	ET DEGATS	IMMAT	PHARES	EFFET	OBSERVATIONS
HEURE	PISTE	MOTEUR	JOUR	VIT	MTO	TAILLE	TOUCH	TOUCHEE	OBSERVES	COUT(F)	AVERTI		
01/01/87	LFPG	EA30	AF	?	DEC	MOUET.RI						AUCUN	
08.30		CF6.50C2R	A	?		MOYEN	2 à 10			?	NON		
02/02/87	LFPG	EA31	AF	?	DEC	PEDRI.GR		MOT1 G		FGEMC		ATTPRUD	4 AUBES HS.RET
09.53	10	CF6.80A3	J	?		MOYEN	1			?	NON		ARD:2H52.ARRET MOT.
14/02/87	LFPG	B747	AF	?		VANO.HUP		MOT3 N		FBPVE		AUCUN	
		JT9D.7		?		MOYEN	1			?	NON		
16/02/87	LFPG	B747	AF	?	ATT	MOUET.RI		MOT4 N		FBPVX	AT+ECL	AUCUN	
		CF6.50E2		?		MOYEN	1			?	NON		
01/03/87	LFPG	EA31	AF	?	ATT	MOUET.RI		PARE N NEZ N		FGEMD	AT+ECL	AUCUN	
10.55		CF6.80A3	J	?		MOYEN	1			?	NON		
17/03/87	LFPG	B747	AF	?	ATT			NEZ L		FBPVV		AUTRE	RETARD:24H.NEZ
		CF6.50E2		?			1			?	NON		BOSSELE.
19/03/87	LFPG	EA30	AF	50	ATT			MOT1 N		FBVGF		AUCUN	
		CF6.50C2R		?			1			?	NON		
20/03/87	LFPG	B747	AF	100	MON	VANO.HUP	11 à 100	AILE N		FBVGJ	AT+ECL	AUCUN	
09.16	27	CF6.50C2	J	153	CLAIR	MOYEN	2 à 10			?	NON		
25/03/87	LFPG	B747	AF	?	ATT	MOUET.RI		MOT1 N		FGCBA		AUCUN	
		CF6.50C2		?		MOYEN	1			?	NON		
27/05/87	LFPG	EA30	AF	0	DEC	MOUET.RI	2 à 10	RADO N		FGBEC		DEC.INT	RETARD:1H
	28	CF6.50C2R		80		MOYEN	1			?	NON		
22/06/87	LFPG	B737	AF	100	APP	MARTINET	1	MOT1 N		FGBYB		AUCUN	POMPAGE STR.
		JT8D.15A		?		PETIT	1			?	NON		
13/08/87	LFPG	B727	AF	2	ATT	CORBO.FR	2 à 10	NEZ N		FBOJC	ATT.	AUCUN	
08.05	28	JT8D.7	J	132	4/8	MOYEN	1			?	NON		
10/09/87	LFPG	B737	AF	10	DEC	FAUC.CRE		MOT2 N		FGBYM		AUCUN	ENDOSCOPIE:RAS
		JT8D.15	J	135		MOYEN	1			?	NON		.
17/09/87	LFPG	B747	AF	?	ATT	ETOUR.SA		MOT1 N		FGCBH		AUCUN	
		CF6.50E2		?		PETIT	1			?	NON		
21/09/87	LFPG	B747	AF	?	APP	PIGEON.C		MOT3 N		FGCBA		AUCUN	
		CF6.50C2R	J	?		MOYEN	1			?	NON		
06/10/87	LFPG	B747	AF	?	APP	SARC.HIV		TRAI N		FBPVT		AUCUN	
		CF6.50E2		?		MOYEN	1			?	NON		
11/10/87	LFPG	B727	AF	150	APP			MOT1 N		FBOJA		AUCUN	
		JT8D.15		?			1			?	NON		
04/11/87	LFPG	B747	AF	?	ATT	VANO.HUP		MOT4 N		FGCBI	AT+ECL	AUCUN	
15.55		CF6.50E2	N	?		MOYEN	1			?	NON		
08/11/87	LFPG	B747	AF	?	APP	PIGEON.R		MOT4 G		FBPVC		AUCUN	2 AUBES FAN HS
		JT9D.7	J	?		MOYEN	1			?	NON		.ENDOSCOPIE:RAS.
08/11/87	LFPG	B747	AF	?	DEC	PEDRI.GR		MOT4 N		N289E		AUTRE	RETARD:1H30 A
		JT9D.7	N	?		MOYEN	1			?	NON		MONTREAL.ENDOSCOPIE:RA

APPENDIX 2

DATE HEURE	LIEU PISTE	AVION MOTEUR	CIE JOUR	HAUT VIT	VOL MTO	OISEAU TAILLE	VUS TOUCH	PARTIE ET TOUCHEE	DEGATS OBSERVES	IMMAT COUT(F)	PHARES AVERTI	EFFET	OBSERVATIONS
17/03/87	LFPO	DA01	IT	200	MON	VANO.HUP	11 à 100	PARE N		FBTTB	AT+ECL	AUCUN	
17.34	25	JT8D.15	C	140	CLAIR	MOYEN	1			?	OUI		
18/03/87	LFPO	EA30	IT	0	ATT	MOUET.RI		AILE N		FBVGE		AUCUN	
	26	CF6.50C2R		?		MOYEN	1			?	NON		
19/03/87	LFPG	EA30	AF	50	ATT			MOT1 N		FBVGP		AUCUN	
		CF6.50C2R		?			1			?	NON		
20/03/87	LFBU	E110	WL	0	DEC		2 à 10	MOT1 N		FGDCI		ATTPRUD	GTR NETTOYE.RA
05.45	-	PT6A34	J	80		MOYEN	1			?	NON		S.
20/03/87	LFPG	B747	AF	100	MON	VANO.HUP	11 à 100	AILE N		FBVGJ	AT+ECL	AUCUN	
09.16	27	CF6.50C2	J	153	CLAIR	MOYEN	2 à 10			?	NON		
23/03/87	LFSB			?		MOUET.RI						AUCUN	INSP.RNW.
	34		J	?		MOYEN	1			?	NON		
23/03/87	LFPG			?	ATT	MOUET.RI						AUCUN	INSP.RNW.
10.00	28		J	?	PLUIE	MOYEN	2 à 10			?	NON		
24/03/87	LFMK	C177	YA	50	DEC	PIGEON.D	2 à 10	AILE L		FGAGB	AT+ECL	ATTPRUD	B.A.AILE DROIT
07.30	28	IO360	J	30	CLAIR	MOYEN	1			?	NON		E ENFONCE.
25/03/87	LFPO	EA30	IT	?	APP			NEZ L		FBUAF		AUCUN	NEZ BOSSELE.
	26	CF6.50C2R		?			1			?	NON		
25/03/87	LFPG	B747	AF	?	ATT	MOUET.RI		MOT1 N		FGCBA		AUCUN	
		CF6.50C2		?		MOYEN	1			?	NON		
25/03/87	EDWD	EA30	IT	?	DEC	MOUET.RI	1	MOT2 G		FBUAF	AT+ECL	ATTPRUD	3 AUBE HT.SANS
		CF6.50C2R	J	?		MOYEN	1			?	NON		SPI.
25/03/87	LFPG	DC9	SR	10	ATT	MOUET.RI	11 à 100	NEZ N		HBINC	AT+ECL	AUCUN	
07.05	27	JT8D.209	J	125	7/8	MOYEN	1			?	OUI		
25/03/87	LFBT	T810	YA	0	DEC	ACCIPITR		AILE N		FGEVH	AT+ECL	AUCUN	
10.15	21	O360A2A	J	60	8/8	GRAND	1			?	NON		
26/03/87	EDDK	B737	AF	700	MON			MOT1 N MOT2 N AILE N		FGBYJ	AT+ECL	ATTPRUD	RETARD:4H.ENDO
19.17	14L	JT8D.15A	N	160	CLAIR		2 à 10			?	NON		SCOPIE:AUBES RETOUCHEE
26/03/87	LF	FK27	AF	10000	MON			NEZ N		FBPUA	ATT.	AUCUN	
22.02		DART532	N	150			1			?	NON		
27/03/87	LFB	EA30	AF	5000	MON			PARE N		FBVGC	AT+ECL	AUCUN	
		CF6.50C2R		0			1			?	NON		
27/03/87	LFBO	S212	IT	0	ATT	ROUGE.GO		AILE N		FGCVK	ATT.	AUCUN	
20.10	15R	JT8D.9	N	130	CLAIR	PETIT	1			?	NON		
28/03/87	LFBO	B737	AF	0	DEC	MOUET.RI	2 à 10	RADO N NEZ N		FGBYF	ATT.	AUCUN	PITOT GAUCHE B
09.40	33R	JT8D.15A	J	120	1/8	MOYEN	1			?	NON		OUCHE.
28/03/87	LFLS	B737	BZ	0	DEC	MOUET.RI	1			GAWSY	AT+ECL	AUCUN	
16.14	27	JT8D.9	J	?	2/8	MOYEN	1			?	NON		
29/03/87	LFMN	B737	LH	0	ATT		1	MOT2 N		DABHS		AUCUN	
11.47	05R	JT8D.15	J	114	4/8	MOYEN	1			?	NON		

DATE	LIEU	AVION	CIE	HAUT	VOL	OISEAU	VUS	PARTIE	ET DEGATS	IMMAT	PHARES	EFFET	OBSERVATIONS
HEURE:	PISTE	MOTEUR	JOUR	VIT	MTO	TAILLE	TOUCH	TOUCHEE	OBSERVES	COUT(F)	AVERTI		
05/03/87	LFMT	EA30	IT	?	ATT			FUSE N		FBUAE	AT+ECL	AUCUN	
		CF6.50C2R	J	?			1			?	NON		
05/03/87	LFSB			?		BUSE.VAR						AUCUN	INSP.RNW.
	16		J	?	3/8	GRAND	1			?	NON		
06/03/87	LF	EA30	IT	?				AILE L		FBUAG		AUCUN	B.A.VOLET DROI
		CF6.50C2R	J	?			1			?	NON		T ENFONCE.
06/03/87	LFBD	BA11	DA	200	MON	VANO.HUP						AUCUN	
14.53	23	SP512.14	J	150	6/8	MOYEN	1			?	OUI		
08/03/87	GOOY	B747	AF	?	ATT			MOT4 G		FGPAN		AUTRE	3 AUBES FAN HS
		CF6.50E2		?			1			?	NON		.RETARD:24H.
10/03/87	LFMP	DA01	IT	0	DEC	MOUET.RI	11 à 100	PARE N		FBTTG	ATT.	AUCUN	+1 GOEL.ARG.
08.06	33	JT8D.15	J	140	PLUIE	MOYEN	2 à 10			?	NON		
10/03/87	LFBE	SW2	WL	40	ATT	VANO.HUP	) 100	MOT1 N		FGCTE	AT+ECL	AUCUN	
08.20	28	TPE331	J	110	PLUIE	MOYEN	1			?	NON		
11/03/87	LF	EA30	IT	?		VANO.HUP		MOT1 N		FBUAN		AUCUN	ENDOSCOPIE:RAS
		CF6.50C2R		?		MOYEN	1			?	NON		.SANS SPI.
12/03/87	LFMN	EA31	AF	?	ATT	MOUET.RI		MOT1 N		FGEMA		AUCUN	ENDOSCOPIE:RAS
		CF6.80A3	J	?		MOYEN	1			?	NON		.RETARD:1H.
12/03/87	LFPG	B747	MD	?	ATT	OEDIC.CR		MOT4 N		5RMFT		AUTRE	RETARD:1H.ENDO
		JT9D.7		?		MOYEN	1			?	NON		SCOPIE:RAS.
12/03/87	LFSO	EA30	IT	?	ATT	CHOUET.E		MOT1 N		FBVGS		AUCUN	ENDOSCOPIE:RAS
		CF6.50C2R	N	?		MOYEN	1			?	NON		.RETARD:2H.
12/03/87	LFLB	PA34	SY	0	ATT	VANO.HUP	11 à 100	HELI N AILE N		FBUIJ	AT+ECL	AUCUN	
06.55	18	IO360CAB	J	95	8/8	MOYEN	2 à 10			?	NON		
13/03/87	LFPO	EA30	IT	0	DEC	VANO.HUP	11 à 100			FGBEA	AT+ECL	DEC.INT	PAS D'IMPACT.E
12.40	25	CF6.50C2R	J	80		MOYEN				?	OUI		FFAROUCHEMENT BDP EN C
13/03/87	NTAA	S210	YX	20	ATT	BUSAR.RO	1	RADO L		FRBPR		AUCUN	RADOME BOSSELE
20.28	04	AVM527	J	110	2/8	GRAND	1			?	NON		.
15/03/87	LFKB	DA01	IT	?		PASSERO		MOT2 N		FBTTJ		AUCUN	
09.15	34	JT8D.15	J	?	CLAIR	PETIT	1			?	NON		
16/03/87	LFPO	EA30	IT	?	ATT	MOUET.RI		MOT2 N		FBVGE		AUCUN	ENDOSCOPIE:RAS
	26	CF6.50C2R	J	?		MOYEN	1			?	NON		.SANS SPI.
16/03/87	LFPO	EA30	IT	20	ATT	MOUET.RI	1	FUSE N		FBUAJ	AT+ECL	AUCUN	
06.19	26	CF6.50C2R	J	120		MOYEN	1			?	OUI		
16/03/87	LFAT	ND26	YA	50	DEC	MOUET.RI	2 à 10	TRAI N		FBOHH	ATT.	AUCUN	
13.15		BAST.6/C	J	130	3/8	MOYEN	1			?	NON		
16/03/87	LFPO	EA30	IT	?	ATT			MOT1 N		FGBEB		AUCUN	ENDOSCOPIE:RAS
14.08	26	CF6.50C2R	J	?			1			?	OUI		.AVEC SPI.
17/03/87	LFPG	B747	AF	?	ATT			NEZ L		FBPVV		AUTRE	RETARD:24H.NEZ
		CF6.50E2		?			1			?	NON		BOSSELE.

APPENDIX 3

TABLEAU 1
Sources des informations sur les collisions oiseaux-aéronefs

		ANNEE	1980	1981	1982	1983	1984	1985	1986	1987
NOMBRE TOTAL D'INCIDENTS			0	0	0	0	0	0	0	436
INFORMATION	TERRAINS	Nombre d'incidents	0	0	0	0	0	0	0	98
		%	****	****	****	****	****	****	****	22.5
	NAVIGANTS	Nombre d'incidents	0	0	0	0	0	0	0	135
		%	****	****	****	****	****	****	****	31.0
	ENTRETIEN	Nombre d'incidents	0	0	0	0	0	0	0	118
		%	****	****	****	****	****	****	****	27.1
	TERRAINS + NAVIGANTS	Nombre d'incidents	0	0	0	0	0	0	0	25
		%	****	****	****	****	****	****	****	5.7
	TERRAINS + ENTRETIEN	Nombre d'incidents	0	0	0	0	0	0	0	9
		%	****	****	****	****	****	****	****	2.1
	NAVIGANTS + ENTRETIEN	Nombre d'incidents	0	0	0	0	0	0	0	36
		%	****	****	****	****	****	****	****	8.3
	TERRAINS NAVIGANTS ENTRETIEN	Nombre d'incidents	0	0	0	0	0	0	0	15
		%	****	****	****	****	****	****	****	3.4

TABLEAU 2
Répartition des incidents par aérodrome
en 1987

AERODROME	AVIATION COMMERCIALE			AVIATION NON COMMERCIALE
	CAS	MVTS	TAUX	COLLISIONS
AJACCIO-CAMPO DELL'ORO	1			1
ANGOULEME-BRIE-CHAMPNIERS	1			
AURILLAC	1			1
BALE-MULHOUSE	12			1
BASTIA-PORETTA	3			
BERGERAC-ROUMANIERE	1			
BEZIERS-VIAS	2			1
BIARRITZ-BAYONNE-ANGLET	9			
BORDEAUX-MERIGNAC	13	156000	0.83	
BREST-GUIPAVAS	9	125000	0.72	
CARCASSONNE-SALVAZA	1			1
CHAMBERY-AIX-LES-BAINS	2			
CHATEAUROUX-DEOLS	1			
CHERBOURG-MAUPERTUS	1			1
CLERMONT-FERRAND-AULNAT	3			
DINARD-PLEURTUIT				1
FREJUS-SAINT-RAPHAEL				1
GRENOBLE-SAINT-GEOIRS	3			1
LA ROCHELLE-LALEU	1			
LE HAVRE-OCTEVILLE	2			1
LE TOUQUET-PARIS-PLAGE	1			2
LILLE-LESQUIN	11			5
LIMOGES-BELLEGARDE	2			
LORIENT-LANN BIHOUE	1			
LYON-SATOLAS	5			
MARSEILLE-PROVENCE	10			1
MELUN-VILLAROCHE	1			2
MONTLUCON-GUERET	1			
MONTPELLIER-FREJORGUES	13			3
MORLAIX-PLOUJEAN	1			
NANTES-CHATEAU-BOUGON	6			
NICE-COTE D'AZUR	15			
NIMES-GARONS	3			
PARIS-CHARLES-DE-GAULLE	43			
PARIS-LE BOURGET	4			5
PARIS-ORLY	42	625000	0.67	
PAU-PONT-LONG-UZEIN	3			
PERPIGNAN-RIVESALTES	3			
POITIERS-BIARD	1			
PONTOISE-CORMEILLES EN VEXIN	1			
QUIMPER-PLUGUFFAN	1			4
RODEZ-MARCILLAC				1
SAINT-NAZAIRE-MONTOIR				1
SAINT-YAN				7
STRASBOURG-ENTZHEIM	4			
TARBES-OSSUN-LOURDES	13			2
TOULON-SAINT-MANDRIER	4			
TOULOUSE-BLAGNAC	15			1
VICHY-CHARMEIL	1			

TABLEAU 3

Taux d'incidents pour 10 000 mouvements commerciaux par aérodromes

AERODROME ANNEE	1980	1981	1982	1983	1984	1985	1986	1987
AGEN-LA GARENNE								
AJACCIO-CAMPO DELL'ORO								
ALBI-LE SEQUESTRE								
AMIENS-GLISY								
ANGERS-AVRILLE								
ANGOULEME-BRIE-CHAMPNIERS								
ANNECY-MEYTHET								
AUBENAS-VALS-LANAS								
AURILLAC								
AUXERRE-MONETEAU								
AVIGNON-CAUMONT								
BALE-MULHOUSE								
BASTIA-PORETTA								
BEAUVAIS-TILLE								
BERGERAC-ROUMANIERE								
BEZIERS-VIAS								
BIARRITZ-BAYONNE-ANGLET								
BORDEAUX-MERIGNAC								0.8
BOURGES								
BREST-GUIPAVAS								0.7
BRIVE-LA ROCHE								
CAEN-CARPIQUET								
CAHORS-LALBENQUE								
CALAIS-DUNKERQUE								
CALVI-SAINTE-CATHERINE								
CANNES-MANDELIEU								
CARCASSONNE-SALVAZA								
CHAMBERY-AIX-LES-BAINS								
CHARLEVILLE-MEZIERES								
CHATEAUDUN								
CHATEAUROUX-DEOLS								
CHERBOURG-MAUPERTUS								
CHOLET-LE PONTREAU								
CLERMONT-FERRAND-AULNAT								
COLMAR-HOUSSEN								
COURCHEVEL								
CUERS-PIERREFEU								
DEAUVILLE-SAINT-GATIEN								
DIEPPE-SAINT-AUBIN								
DIJON-LONGVIC								
DINARD-PLEURTUIT								
DOLE-TAVAUX								
EPINAL-MIRECOURT								
FIGARI								
FREJUS-SAINT-RAPHAEL								
GAP-TALLARD								
GRANVILLE								
GRENOBLE-SAINT-GEOIRS								
HYERES-LE PALYVESTRE								
ILE D'YEU-LE GRAND PHARE								
ISTRES-LE TUBE								
LA ROCHELLE-LALEU								
LA ROCHE/YON-LES AJONCS								
LANNION-SERVEL								
LAVAL-ENTRAMMES								
LE HAVRE-OCTEVILLE								
LE MANS-ARNAGE								

TABLEAU 3

Taux d'incidents pour 10 000 mouvements commerciaux par aérodromes

AERODROME ANNEE	1980	1981	1982	1983	1984	1985	1986	1987
LE PUY-LOUDES								
LE TOUQUET-PARIS-PLAGE								
LILLE-LESQUIN								
LIMOGES-BELLEGARDE								
LORIENT-LANN BIHOUE								
LYON-BRON								
LYON-SATOLAS								
MACON-CHARNAY								
MARSEILLE-PROVENCE								
MELUN-VILLAROCHE								
METZ-FRESCATY								
MONTLUCON-GUERET								
MONTPELLIER-FREJORGUES								
MORLAIX-PLOUJEAN								
NANCY-ESSEY								
NANTES-CHATEAU-BOUGON								
NEVERS-FOURCHAMBAULT								
NICE-COTE D'AZUR								
NIMES-GARONS								
NIORT-SOUCHE								
OUESSANT								
PARIS-CHARLES-DE-GAULLE								
PARIS-LE BOURGET								
PARIS-ORLY								0.7
PAU-PONT-LONG-UZEIN								
PERIGUEUX-BASSILLAC								
PERPIGNAN-RIVESALTES								
POITIERS-BIARD								
PONTOISE-CORMEILLES EN VEXIN								
QUIMPER-PLUGUFFAN								
REIMS-CHAMPAGNE								
RENNES-SAINT-JACQUES								
ROANNE-RENAISON								
RODEZ-MARCILLAC								
ROUEN-BOOS								
ROYAN-MEDIS								
SAINT-BRIEUC-ARMOR								
SAINT-ETIENNE-BOUTHEON								
SAINT-NAZAIRE-MONTOIR								
SAINT-YAN								
STRASBOURG-ENTZHEIM								
TARBES-OSSUN-LOURDES								
TOULON-SAINT-MANDRIER								
TOULOUSE-BLAGNAC								
TOURS-SAINT-SYMPHORIEN								
TOUSSUS-LE NOBLE								
TROYES-BARBEREY								
VALENCE-CHABEUIL								
VALENCIENNES-DENAIN								
VANNES-MEUCON								
VICHY-CHARMEIL								

TABLEAU 5

Distribution mensuelle des collisions par espèce d'oiseaux

	ESPECE D'OISEAUX / MOIS	JAN	FEV	MAR	AVR	MAI	JUN	JUI	AOU	SEP	OCT	NOV	DEC	TOT
1987	MOUETTES/GOELANDS	8	19	13	1	2	2	3	10	6	16	7	11	98
	VANNEAUX HUPPES	2	5	8								5	4	24
	PIGEONS			1		1	4	11	2	2		1		22
	HIRONDELLES/MARTINETS					3	6	8	5	3	2			27
	RAPACES DIURNES	5	2	2	2	3	6	12	4	2	3	1	1	43
	ETOURNEAUX									1				1
	AUTRES ET INCONNUS	10	4	14	10	9	13	12	22	20	29	15	5	163
	TOTAL	25	30	38	13	18	31	46	43	34	50	29	21	378

TABLEAU 6
Espèces d'oiseaux rencontrées en 1987

ESPECE D'OISEAU		POIDS (g)	NBR DE CAS
NOM COMMUN	NOM LATIN		
INCONNUS			107
RAPACES DIURNES	ACCIPITRIDAE		6
ALOUETTE DES CHAMPS	ALAUDA ARVENSIS	38	4
BECASSE DES BOIS	SCOLOPAX RUSTICOLA	300	1
BUSARD DES ROSEAUX	CIRCUS AERUGINOSUS	630	1
BUSE VARIABLE	BUTEO BUTEO	900	20
BUSE OU MILAN			8
CHEVALIER COMBATTANT	PHILOMACHUS PUGNAX	140	1
CHOUETTE EFFRAIE	TYTO ALBA	315	6
CORBEAU FREUX	CORVUS FRUGILEGUS	430	3
CORNEILLE NOIRE	CORVUS CORONE	530	1
ENGOULEVENT D'EUROPE	CAPRIMULGUS EUROPAEUS	70	2
ETOURNEAU SANSONNET	STURNUS VULGARIS	80	1
FAUCON CRECERELLE	FALCO TINUNCULUS	200	13
FAUCON HOBEREAU	FALCO SUBBUTEO	200	1
GOELAND ARGENTE	LARUS ARGENTATUS	1100	9
GOELAND CENDRE	LARUS CANUS	420	2
GRIVE MUSICIENNE	TURDUS PHILOMELOS	74	1
HIBOU BRACHYOTE	ASIO FLAMMEUS	355	3
HIRONDELLE DES CHEMINEES	HIRUNDO RUSTICA	18	4
HIRONDELLES OU MARTINETS	HIRUNDINIDAE OU APODIDAE		14
MARTINET NOIR	APUS APUS	40	9
MILAN NOIR	MILVUS MIGRANS	1000	8
MOUETTE RIEUSE	LARUS RIDIBUNDUS	300	86
MOUETTES OU GOELANDS	LARIDAE		1
OEDICNEME CRIARD	BURHINUS OEDICNEMUS	450	1
OUTARDE CANEPETIERE	TETRAX TETRAX	820	3
PASSEREAUX	PASSERIFORMES		1
PERDRIX CHOUKAR	ALECTORIS CHUKAR	500	1
PERDRIX GRISE	PERDIX PERDIX	350	11
PIE BAVARDE	PICA PICA	220	1
PIGEON COLOMBIN	COLUMBA OENAS	345	3
PIGEON DOMESTIQUE	COLUMBA LIVIA	260	14
PIGEON RAMIER	COLUMBA PALUMBUS	465	3
PIGEON SP.	COLUMBIDAE		2
ROUGE-GORGE	ERITHACUS RUBECULA	18	1
SARCELLES D'HIVER	ANAS CRECCA	324	1
VANNEAU HUPPE	VANELLUS VANELLUS	250	24

TABLEAU 7
Nombre d'incidents par type d'avions pour l'année 1987

MODE DE PROPULSION	TYPE D'APPAREIL OACI 8643/11	NOMBRE DE COLLISIONS		NOMBRE DE MVTS AF.IT.UT	TAUX POUR 10 000 MOUVEMENTS
		TOTAL	AF.IT.UT		
REACTEUR	B707	2			
	B720	1			
	B727	27	20		
	B737	29	14	34089	4.11
	B747	25	23		
	BA11	6			
	C500	1			
	C550	1			
	DA01	32	32		
	DA10	2			
	DA20	2			
	DA50	1			
	DC10	5	3		
	DC8	1			
	DC9	14	1		
	EA30	137	134		
	EA31	11	8		
	FK28	2	1		
	HS25	1			
	LR24	1			
	MD80	1			
	S210	2			
	S212	15	15		
	S601	2			
	TOTAL	321	251	34089	73.63
TURBO	AP25	1			
	AT42	3	1		
	BE55	1			
	BE90	2			
	C208	1			
	C425	1			
	DO81	1			
	E110	10			
	E120	2			
	E121	2			
	FK27	10	7		
	ND26	12			
	SF34	1			
	VC9	2			
	TOTAL	49	8	0	******
PISTON	ATL	1			
	BE10	2			
	BE20	1			
	BE58	2			
	C150	1			
	C172	1			
	C177	3			
	C182	1			
	C310	4			
	C340	1			
	C402	1			

TABLEAU 7 (suite)
Nombre d'incidents par type d'avions pour l'année 1987

MODE DE PROPULSION	TYPE D'APPAREIL OACI 8643/11	NOMBRE DE COLLISIONS		NOMBRE DE MVTS AF.IT.UT	TAUX POUR 10 000 MOUVEMENTS
		TOTAL	AF.IT.UT		
PISTON	DR31	1			
	DR36	1			
	DR38	1			
	DR40	4			
	HR10	1			
	PA25	1			
	PA34	2			
	PA38	1			
	R200	1			
	R300	1			
	S880	3			
	SW2	2			
	SW4	1			
	TB10	1			
	TB20	2			
	YK18	1			
	TOTAL	42	0	0	******

TABLEAU 9

Nombre d'incidents par compagnie pour l'année 1987

COMPAGNIE	NOMBRE DE COLLISIONS			NOMBRE DE MOUVEMENTS	TAUX/ 10000 MVTS
	FRANCE	ETRANG	TOTAL		
AER LINGUS	1		1		
AIR ALGERIE	2		2		
AIR ALSACE	1		1		
AIR FRANCE	51	44	95	236364	4.0
AIR INTER	157	3	160		
AIR JET	1		1		
AIR LIMOUSIN	3		3		
AIR LITTORAL	7		7		
AIR MADAGASCAR	2		2		
AIR MAURITIUS	1	1	2		
AIR PORTUGAL	1		1		
AIR TAHITI		1	1		
ALITALIA	3		3		
ARAX AIRLINES	1		1		
BALAIR	1		1		
BRIT AIR	5		5		
BRITISH CALEDONIAN	4		4		
BRITISH ISLAND AIRWAYS	1		1		
CHARTER	2		2		
CIE AERIENNE DU LANGUEDOC	6		6		
COMPAGNIE AEROMARITIME	1		1		
CONAIR	1		1		
CORSE AIR INTERNATIONAL	1		1		
CROSSAIR	1		1		
DANAIR	1		1		
ETAT	19		19		
EURALAIR	6		6		
EURALAIR INTERNATIONAL	1		1		
LUFTHANSA	8		8		
MILITAIRES	5	2	7		
MINERVE		1	1		
PAN AMERICAN	2	1	3		
PRIVE	30	1	31		
SCANDINAVIAN AIR SERVICE	1		1		
SOBELAIR	1		1		
SOUTH AFRICAN AIRWAYS	1		1		
SWISSAIR	12		12		
TAXIS	7		7		
TRANS EUROPEAN AIRWAYS	3		3		
TRANSPORT AIR TOURAINE	2		2		
U.T.A	2	4	6		

TABLEAU 10
Localisation des impacts en 1987

PARTIE TOUCHEE	NOMBRE DE COLLISIONS	POURCENTAGE BASE SUR 378 CAS
Radome	25	6.61
Pare-brise	34	8.99
Nez	47	12.43
Moteurs	129	34.13
Voilure	54	14.29
Fuselage	35	9.26
Train	22	5.82
Empennage	2	0.53
Feux	3	0.79

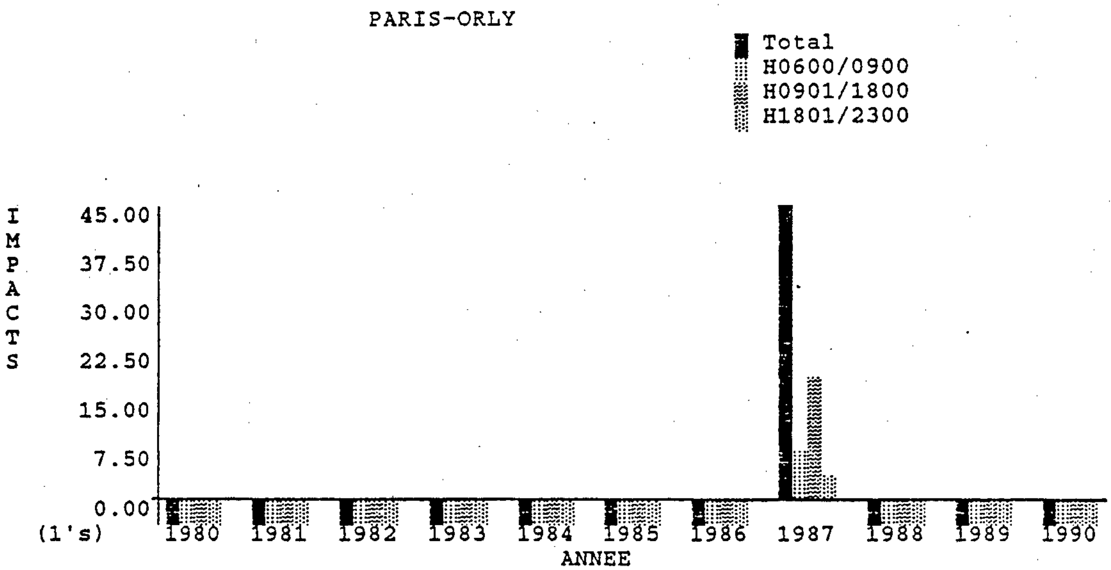
TABLEAU 13
Conséquences sur le vol pour l'année 1987

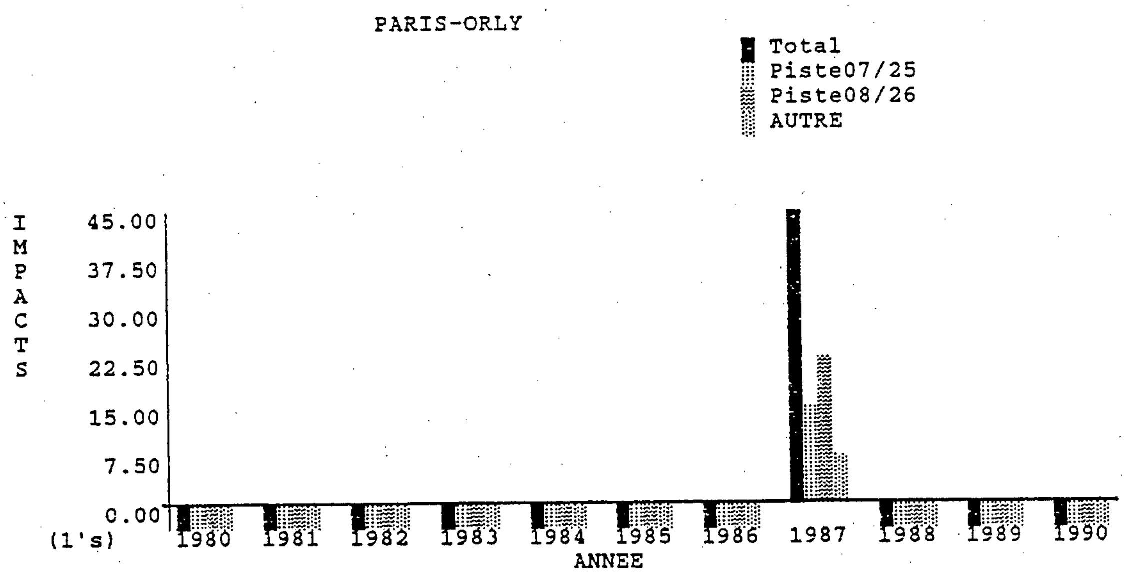
CONSEQUENCES SUR LE VOL	NOMBRE DE COLLISIONS	POURCENTAGE BASE SUR 373 CAS
RETARD D'EXPLOITATION	46	12.3
ATTERRISSAGE DE PRUDENCE	17	4.56
DECOLLAGE INTERROMPU	18	4.83

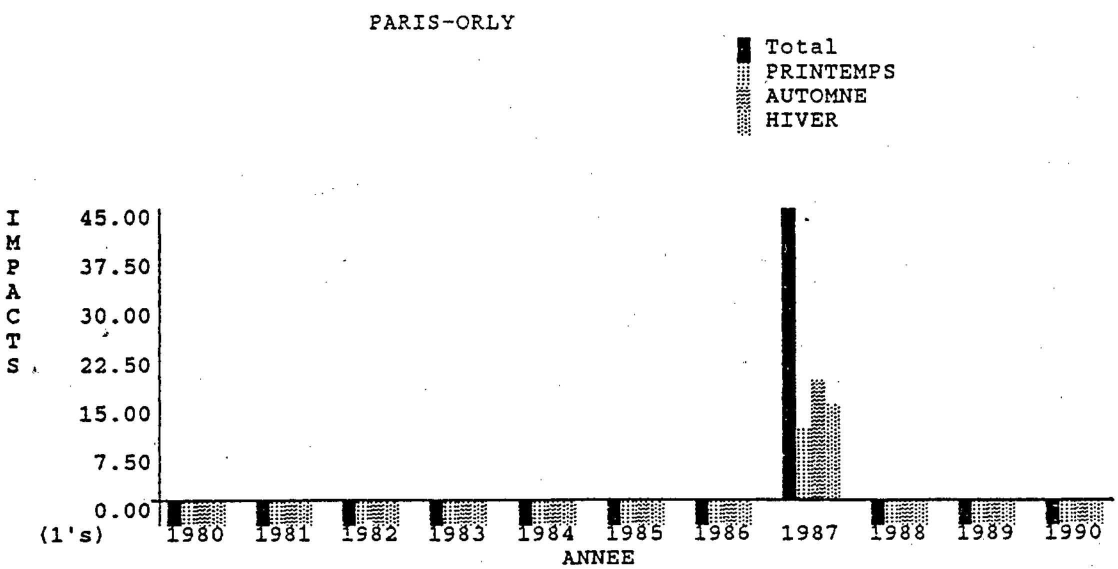
TABLEAU 14
Nombre d'incidents par phase de vol en 1987

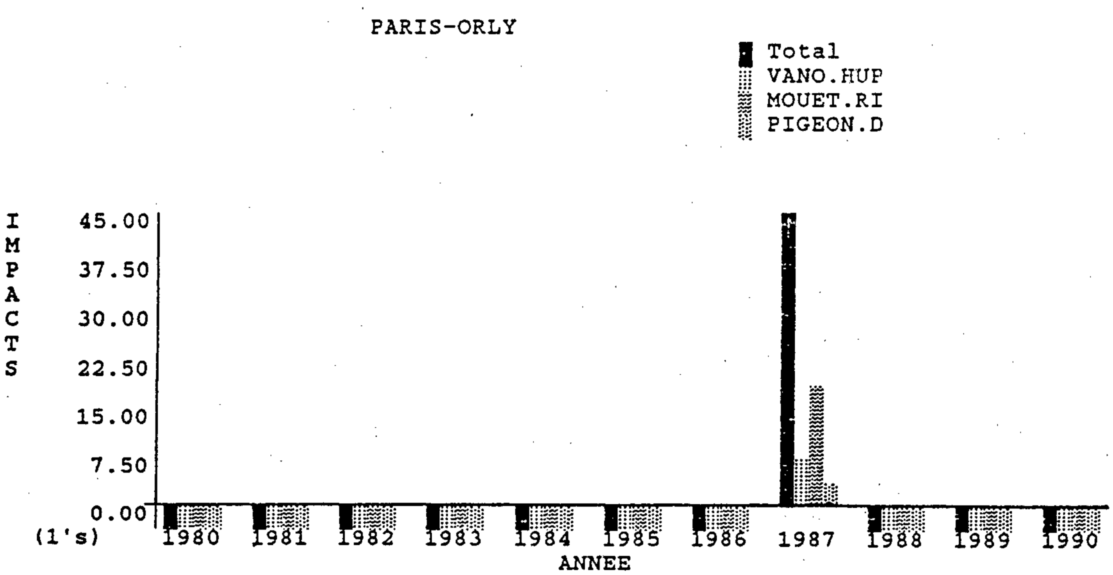
PHASE DE VOL	NOMBRE DE COLLISIONS	POURCENTAGE BASE SUR 378 CAS
Inconnue	57	15.1
Approche (100-50ft)	22	5.82
Atterrissage (<50ft)	126	33.3
Circulation au sol	3	0.79
Croisière	4	1.06
Décollage (0-50ft)	112	29.6
Descente	26	6.88
Montée (>50ft)	28	7.41

APPENDIX 4


PARIS-ORLY
Total
H0600/0900
H0901/1800
H1801/2300
IMPACTS
45.00
37.50
30.00
22.50
15.00
7.50
0.00
(1's)
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
ANNEE


PARIS-ORLY
Total
Piste07/25
Piste08/26
AUTRE
IMPACTS
45.00
37.50
30.00
22.50
15.00
7.50
0.00
(1's)
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
ANNEE


PARIS-ORLY
Total
PRINTEMPS
AUTOMNE
HIVER
IMPACTS
45.00
37.50
30.00
22.50
15.00
7.50
0.00
(1's)
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
ANNEE


PARIS-ORLY
Total
VANO.HUP
MOUET.RI
PIGEON.D
IMPACTS
45.00
37.50
30.00
22.50
15.00
7.50
0.00
(1's)
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
ANNEE

APPENDIX 5

TABLE 3
BIRD SPECIES

COMMON NAME	SCIENTIFIC NAME	APPROX WEIGHT (g)	CAT	NUMBER OF STRIKES		% BASED ON271
				TOTAL	DAMAGE	
ALOUETTE DES CHAMPS	ALAUDA ARVENSIS	38	A	4		1.5
BECASSE DES BOIS	SCOLOPAX RUSTICOLA	300	B	1		0.4
BUSARD DES ROSEAUX	CIRCUS AERUGINOSUS	630	B	1		0.4
BUSE OU MILAN			B	8		3.0
BUSE VARIABLE	BUTEO BUTEO	900	B	20		7.4
CHEVALIER COMBATTANT	PHILOMACHUS PUGNAX	140	B	1		0.4
CHOUETTE EFFRAIE	TYTO ALBA	315	B	6		2.2
CORBEAU FREUX	CORVUS FRUGILEGUS	430	B	3		1.1
CORNEILLE NOIRE	CORVUS CORONE	530	B	1		0.4
ENGOULEVENT D'EUROPE	CAPRIMULGUS EUROPAEUS	70	A	2		0.7
ETOURNEAU SANSONNET	STURNUS VULGARIS	80	A	1		0.4
FAUCON CRECERELLE	FALCO TINUNCULUS	200	B	13		4.8
FAUCON HOBEREAU	FALCO SUBBUTEO	200	B	1		0.4
GOELAND ARGENTE	LARUS ARGENTATUS	1100	B	9		3.3
GOELAND CENDRE	LARUS CANUS	420	B	2		0.7
GRIVE MUSICIENNE	TURDUS PHILOMELOS	74	A	1		0.4
HIBOU BRACHYOTE	ASIO FLAMMEUS	355	B	3		1.1
HIBOU MOYEN-DUC	ASIO HOTUS	275	B	1		0.4
HIRONDELLE DES CHEMINEES	HIRUNDO RUSTICA	18	A	4		1.5
HIRONDELLES OU MARTINETS	HIRUNDINIDAE OU APODIDAE		A	14		5.2
MARTINET NOIR	APUS APUS	40	A	9		3.3
MILAN NOIR	MILVUS MIGRANS	1000	B	8		3.0
MOUETTE RIEUSE	LARUS RIDIBUNDUS	300	B	86		31.7
MOUETTES OU GOELANDS	LARIDAE		B	1		0.4
OEDICNEME CRIARD	BURHINUS OEDICNEMUS	450	B	1		0.4
OUTARDE CANEPETIERE	TETRAX TETRAX	820	B	3		1.1
PASSEREAUX	PASSERIFORMES		B	1		0.4
PERDRIX CHOUKAR	ALECTORIS CHUKAR	500	B	1		0.4
PERDRIX GRISE	PERDIX PERDIX	350	B	11		4.1
PIE BAVARDE	PICA PICA	220	B	1		0.4
PIGEON COLOMBIN	COLUMBA OENAS	345	B	3		1.1
PIGEON DOMESTIQUE	COLUMBA LIVIA	260	B	14		5.2
PIGEON RAMIER	COLUMBA PALUMBUS	465	B	3		1.1
PIGEON SP.	COLUMBIDAE		B	2		0.7
RAPACES DIURNES	ACCIPITRIDAE		B	6		2.2
ROUGE-GORGE	ERITHACUS RUBECULA	18	A	1		0.4
SARCELLES D'HIVER	ANAS CRECCA	324	B	1		0.4
VANNEAU HUPPE	VANELLUS VANELLUS	250	B	24		8.9
UNKNOWN				107		
TOTAL				378		

APPENDIX 6

OPER AIRC	ENGINE REGISTR	DATE TIME	DAY AIRP	RWY HEIGH	IAS PHA	PART STRUCK AND PART DAMAGED	EFF SKY	PRECI BIRD	SEE STR	SIZ PW	REMARKS
AF	2207	01/01/87	A		?		32			M	
04101		08.30	LFPG	?	C			NE136	B	N	
IT	2207	01/01/87	B	23	125	21/S	32			S	ENDOSCOPIE:RAS.AVEC SPI
04101	FBUAJ	09.30	LFTR	?	H		A	?	A	N	
UT	2207	02/01/87	A		?	21/S	32			M	
58326	FBTDB	05.00	FKKD	?	?		A	R1101	A	N	
SR	3410	03/01/87	B	09	150	26/S	32		C	M	
58319	HBIDO	11.04	LFPG	?	C		A	NE136	B	N	
IT	3410	05/01/87	A	23	132	19/S	32		A	M	
03117	F6CVJ	06.00	LFTR	?	C			R1101	A	N	
	?	05/01/87	B	16	?		32			M	INSP.RNW.
?		08.45	LFSB	?	?			R2004	A		
AF	2207	06/01/87			?	21/D	32				2 AUBES FAN IT.CDG-LHR
04101	FBVGB	?		?	?			?	A	N	
IT	2207	08/01/87		25	?		33				PAS D'IMPACT.RETARD:0H40.
04101	FBUAI	12.24	LFPO	?	C			?			
IT	3410	10/01/87	B	31	130	26/S 27/S	32	39	D	M	+MOUET.RI
30007	FBTTJ	09.20	LFBP	?	F		C	N5201	B	N	
XZ	1316	10/01/87	B	26	?	19/S 26/S	32		C	M	
12311	FBTCR	11.40	LFRH	?	H		A	N5201	B	N	
LH	3410	12/01/87	D	10	100	26/S	32		A	M	
14810	DABKD	18.03	LFPG	?	C		B	?	A	N	
FU	4313	15/01/87	A	09	?		32		B	M	
03103	FGBEK	05.25	LFBZ	?	C			NE102	B	N	
XZ	3104	15/01/87	C	29	135	15/S 20/S 21/S 22/S	32	38	C	M	
33201	FGCLA	17.05	LFBD	?	C	26/S	B	NE136	B	N	
IT	3410	16/01/87	B	32R	?	26/S	32		B	M	
03117	FBNOH	08.15	LFML	?	C		B	NE136	B	N	
IT	3410	19/01/87	D	05	120	22/S	33		A	M	RETARD:1H.
30007	FBTTI	?	LFTR	?	C		A	R1101	A	N	
IT	3410	19/01/87	D	26	120	21/S	32	38	A	M	INSP.GTR.
03117	FBTOA	21.19	LFRB	?	H		C	NE136	A	N	
IT	2207	21/01/87	A	29	?	22/S	32				INSP.GTR.
04101	FBVGF	06.55	LFBD	?	F			?	A	N	
IT	3410	23/01/87			?	22/D	32				2 AUBES CHEVAUCHEES.MOT.DEPOSE.
30007	FBTTE	?	LF	?	?			?	A	N	
XX	1316	25/01/87	B	16	?		32		B	L	
	HBLIO	14.25	LFSB	?	H		C	K3401	A	N	
SR	3410	26/01/87	B	16	123	20/S	32		A	L	
58319	HBIFH	10.12	LFSB	?	H		B	K3401	A	N	

OPER AIRC	ENGINE REGISTR	DATE TIME	DAY AIRF	RWY HEIGH	IAS PHA	PART STRUCK AND PART DAMAGED	EFF SKY	PRECI BIRD	SEE STR	SIZ PW	REMARKS
IT	3410	26/01/87	D	27	140	15/S	32			M	
30007	FBTTJ	19.55	LFBZ	?	G			N6010	A	N	
XX	1901	27/01/87	B		?	21/S	36			L	ARRET VOL ENTRAINEMENT POUR INSP.
30002	F6FBG	15.10	LFMT	?	H			K3501	A	N	
IJ	?	29/01/87	B		?		32		B	M	
37204		08.10	LFLB	?	H			NE136	B	N	
LX	2222	29/01/87	B	16	?		32			L	
	HBAHI	09.40	LFSB	?	H		C	K3401	A	N	
IT	2207	31/01/87	B		?	21/D	32			M	2 AUBES FAN IT.SANS SPI.
04101	FBUAI	?	LFBP	?	C			NE136	A	N	
PA	3410	31/01/87		27	?	26/S	32			M	
14810	N362	?	LFPG	?	H			L43	A	N	
IT	2207	31/01/87	B	36	130	22/D			A	L	ENDOSCOPIE:TUYAU HS.ENTRAIN.CNL.S
04101	FBVGE	07.20	LFTW	?	C		A	K3401	A	N	ANS SPI
AF	2207	02/02/87	B	10	?	21/D	34			M	4 AUBES HS.RETARD:2H52.ARRET MOT.
04102	F6EMC	09.53	LFPG	?	C			L4001	A	N	
IT	2207	03/02/87	B		?	27/S	32			M	
04101	FBUAG	?	LFML	?	C			NE136	A	N	
	?	04/02/87		16	?		32			L	INSP.RNW.
?		?	LFSB	?	?			K3401	A		
IT	2207	04/02/87	A	07	120	21/S 26/S	32	38		M	ENDOSCOPIE:RAS.SANS SPI.
04101	FBUAF	06.50	LFPO	?	H		C	NE136	B		
IT	3410	04/02/87	B	36	130	19/S	32	39	B	M	
30007	FBTTH	07.30	LFTL	?	C		E	NE136	A	N	
IT	2207	05/02/87	B	23	?	21/S	33	38	B	M	ENDOSCOPIE:RAS.RETARD:1H25.SANS S
04101	FBUAF	07.42	LFBD	?	C		C	NE136	B	N	PI.
IT	2207	07/02/87	B	26	125	18/S 20/S 22/S 26/S	32	39	C	M	
04101	FBUAE	07.58	LFPC	?	H	27/S 28/S	C	NE136	C	Y	
IT	2207	09/02/87	B	26	?	22/S		39	C	M	ENDOSCOPIE:RAS.RETARD:16MN.AVEC S
04101	F6BEB	09.38	LFPO	?	H		C	NE136	A	Y	PI.
YX	2207	11/02/87	B	04	?	27/S	32			M	
30003	FYDGB	21.35	NTAA	?	H		B	I1301	A	N	
LH	2207	12/02/87	B	27	130	26/S	32		B	M	VOLET TOUCHE.
04102	DAICF	12.50	LFPG	?	H		B	NE136	A	N	
XZ	2210	13/02/87	D	07	100	21/S	32			M	
39502	F6ECI	18.55	LFPB	?	H			N5201	A	N	
IT	2207	14/02/87	B	26	?		32		C	M	
04101		?	LFPO	?	H			NE136	C	Y	
AF	3413	14/02/87			?	23/S	32			M	
14815	FBPVE	?	LFPG	?	?			N5201	A	N	

ADF616026

Bird Strikes at Israel Ben-Gurion Airport 1982-1986

(Shalom Suaretz, Ilana, Agat, Eyal, Shy, Israel)

BSCE 19/WP 29
Madrid, 23-28 May 1988

BIRD STRIKES AT ISRAEL BEN-GURION AIRPORT 1982-1986

SHALOM SUARETZ, ILANA AGAT, EYAL SHY

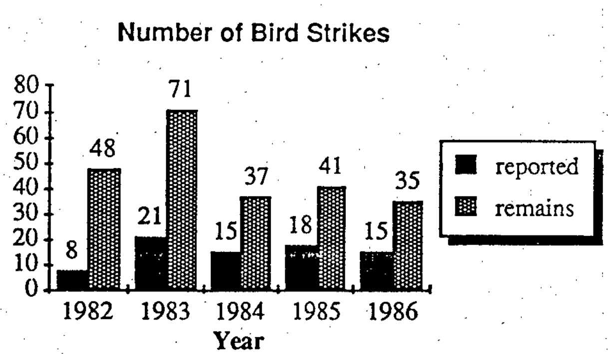
Bird Strike Prevention Unit, Nature Reserves Authority, Ben-Gurion Airport, P.O. Box 126, Israel 70100

Introduction

This report includes data about bird strikes at Ben-Gurion International Airport in Israel during a five year period. We will present the data according the various factors that may influence the number of bird strikes, and according to the effect of bird strikes on normal airplane flights. This presentation does not include statistical tests, as in many of the cases sample size are too small, but rather show trends.

Figure 1 presents the number of bird strikes in a five year period. We divided the data into two types. "Reported strikes" are those reported by pilots, engineers, or others. "Remains" are those strikes in which bird remains are found on the runways, but no other data about the strike is available. During 1982-1986, 77 reported strikes, and 232 cases in which bird remains were found, occurred at Ben-Gurion International Airport (BGA). The number of reported strikes is much smaller than the number of bird remains found.

Figure 1

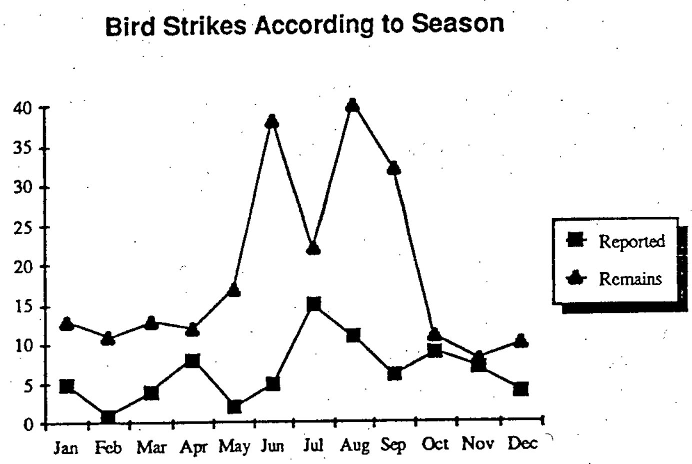


In this Figure, the number of reported strikes in the first year (1982) is much smaller than the number of strikes in each of the following years. This might be due to no reports on some strikes (notice that the number of cases in which bird remains were found that year are high).

Seasonal changes in bird strikes

In the following Figure 2 the changes in the number of strikes during the year are shown for the five year period.

<u>Figure 2</u>



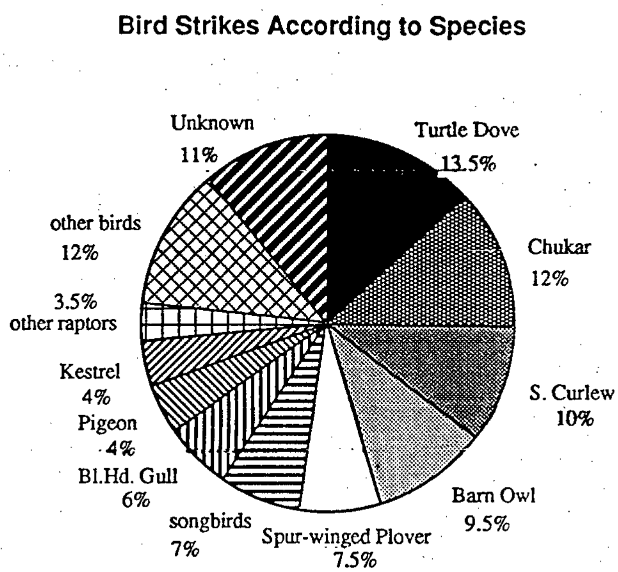
The graph shows that the three summer months, June, July, and August, are the most problematic with regard to bird strikes. About 40% of the reported strikes occurred and 43% of the bird remains were found during this period. The least number of strikes occurred during the winter period (13% of reported strikes, and 17% of bird remains). To understand this pattern it is important to know which birds take part in collision with airplanes.

The bird species that collide with airplanes

Forty-two species of birds collided with airplanes during the five year period. However, in many of them, this occurred only once or twice. The following pie chart represents the percentage of strikes according to bird species. According to the chart, The Turtle Dove is the main species involved in bird strikes. This is due to one particular autumn (1983) in which many of them hit airplanes, during migration through Israel.

The species Chukar, Barn Owl, and Spur-winged Plover are found in Israel all year round, and with the Stone Curlew nest close to or within Ben-Gurion Airport. Their presence at the airport during the breeding season with young may well explain the highest number of bird strikes during the spring and summer. The higher number of day flights during the summer may be another factor which contributes to this high number of strikes. Songbirds were the cause of 7% of the strikes. However, this figure is low relatively to the high number of songbirds found in the airport area, especially during migration seasons.

Figure 3



Black-headed Gulls winter in Israel, and thousands of them are found in the airport area on a big garbage dump. However, only four strikes occurred above the garbage dump during the five year period, and in other 11 cases gull remains were found.

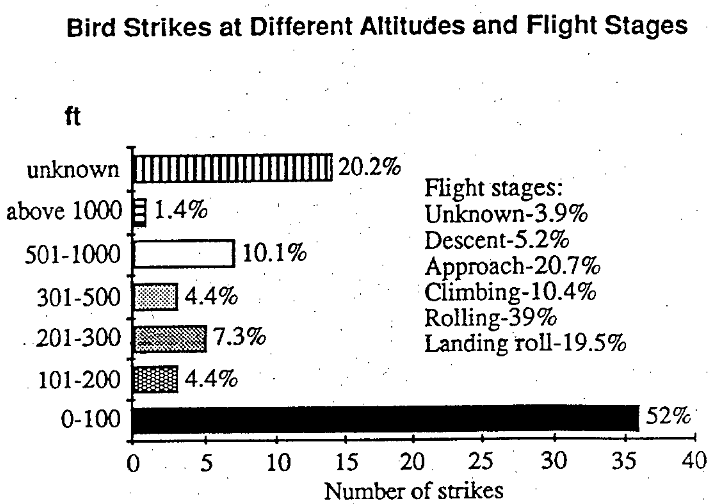
Distribution of bird strikes during the day

The majority of bird strikes occurred during the day (53% from sunrise to sunset). Another 15.6% of the strikes happened during the night. Stone Curlews and Barn Owls are active during the night and may be the main cause of the strikes. A much lower percentage of strikes occurred at dawn and at dusk (3.9% in each), in spite of the fact that birds are very active during dawn and dusk, especially during the hot season. However, this distribution of strikes may reflect the relative high number of flights during the day.

Altitude and flight stage during bird strikes

The next figure describes at what altitude and flight stages bird strikes occurred. As seen in the figure, more than half of the strikes occurred at less than 100 ft, and 64% at 300 ft and less. In analyzing the distribution of strikes according to flight stage, 60% of them occurred during rolling and landing roll. Therefore, bird strikes at BGA occur mainly at very low altitudes.

Figure 4



The effect of bird strikes on the flight, and damage caused by them to airplanes

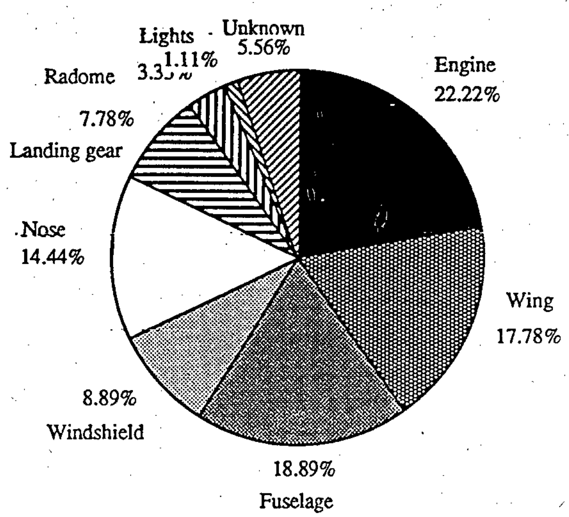
The cost of bird strikes is measured by the influence of the strike on the schedule of the flight, by damage caused to airplanes, and sometimes to human life. Fortunately, only the first two types occurred in BGA during 1982-1986. There was no influence of bird strikes on the flight in 86% of the cases. The airplane stopped rolling in 9% and landed in 5% of the bird strikes.

In most of the flights (75%) no damage was caused to the airplane. However, in 9% of the strikes serious damage was reported, and in 4% medium damage, and in 12% light damage was noticed. We do not have data on the damage caused in terms of money. The type of damage was reported to us by people who examined the airplane after the strike.

The last figure in our report shows the effect of bird strikes on various part of the airplane.

Figure 5

Bird Strikes According to Airplane Part



The chart shows that the main parts to which birds cause damage are the engine,fuselage, wing and nose in this order of magnitude.

Conclusion

We presented here some data about bird strikes that occurred at the Ben-Gurion International Airport in Israel during a period of five years. We have some ideas about the factors that might be involved in these bird strikes. It is more difficult to draw operative conclusions from this data. The trends that are seen in some of the figures should be watched carefully and compared to other factors that might be involved. For example, we hope to be able to distinguish in the future between the contribution of the type of birds involved, and that of the number of flights to the seasonal changes in bird strikes.

ADF616027

Advantages and limitations of Radio-Controller aircraft in bird dispersal

(Albert E. Bivings, EE.UU.)

BSCE 19/WP 30

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ADVANTAGES AND LIMITATIONS OF RADIO-CONTROLLED AIRCRAFT IN BIRD DISPERSAL

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ABSTRACT

Radio-controlled aircraft were utilized to attempt to scare birds out of agricultural crops, staging or loafing areas, transit lanes, and roosts. Positive results were obtained for most birds tested in crops, staging and loafing areas, and transit lanes. Poor results were obtained at roosting areas. Dense escape cover at roost sites was thought to be the major reason roost scaring was ineffective.

Simulation of a noisy aerial predator, lack of habituation, increased area covered, and better control of displaced birds were the major advantages of this technique. Difficulty in flying, limited endurance, high maintenance and acquisition costs, and limited ability to operate in adverse weather were the major limitations. The conclusion was that radio-controlled aircraft offer a good tool under a wide variety of circumstances, but should not be expected to be the only tool used to resolve all possible problems.

I - INTRODUCTION

There is a strong desire among wildlife managers to have a bird control system which is inexpensive, effective, and labor saving with no habituation problems. One obvious solution is an avian predator which can cover a large area, yet birds do not lose their fear of it. DeFusco and Nager (1983) reviewed published literature documenting most bird frightening devices. These included hawk kites, predator models, falconry, and radio-controlled (R/C) aircraft. They found data to support the effectiveness of R/C aircraft in dispersing many kinds of birds. However, not much practical field testing has been reported. The purpose of this paper is to allow the author, an experienced Naval Aviator and helicopter pilot, to examine the advantages and limitations of R/C aircraft for aerodrome bird control from the practical point-of-view of a working field wildlife biologist.

II - METHODS

Field work was conducted with two different aircraft over approximately a one year period. The initial aircraft was a high-wing trainer with a wingspan of approximately 1.5 meters requiring a 4-channel radio (throttle, rudder, elevator, and ailerons). The engine was a 2-cycle gasoline engine of approximately 6.5 cc displacement producing 1.2 bhp at 16,000 rpm. The second aircraft was a high-wing advanced trainer with a 2 meter wingspan requiring a 5-channel radio (throttle, rudder, elevator, ailerons and flaps). This engine was a 2-cycle gasoline engine of approximately 7.5 cc displacement producing 1.4 bhp at 16,000 rpm. Both had fixed landing gear and were brightly colored to enhance visibilitv.

Aircraft were flown over birds feeding in small grain crops or on water, loafing in trees or open areas, at roost sites or transiting the area. Results were subjectively compared to what would be expected from a conventional scaring program of bio-acoustics and pyrotechnics.

III - RESULTS

3.1 - Site results

Birds feeding in mature agricultural crops and on aquaculture ponds responded well to overflights of test aircraft. Lack of protective cover, loud noise, and high visibility are the principal factors. Birds that flushed could then be herded away from the area because of the slow air speed of the test aircraft.

Birds transiting the area also responded extremely well. Aircraft tested had sufficient power to climb above slow flying birds (especially herons and egrets) to make a high speed dive on the flocks simulating a falcon or eagle attack, which caused considerable distress to the birds. Herding the birds was then a matter of maintaining a high orbit to keep the birds moving in any desired direction.

Birds loafing or staging prior to roosting also responded well to R/C aircraft. Again, lack of escape cover and noise of the aircraft seemed to be the most likely reasons for this effectiveness. However, it was more difficult to herd birds away from their intended direction at staging areas prior to roosting than at other sites.

Birds at roost sites did not respond very well to scaring. This was the only category where R/C aircraft failed to perform as well as, or better than, an individual using conventional scaring techniques. Most of these roost sites tested had dense vegetation not normally encountered at aerodromes. As expected, R/C aircraft was not effective on nesting birds.

3.2 - Species-specific results

Of all birds tested, geese responded the best. It takes a fast aircraft to catch up with them because they respond to sight or sound at such a great distance. Ducks (Anatadae), herons and egrets (Ardeidae), house sparrows (Passer domesticus), and shore birds (Charadriidae and Scolopacidae) also responded extremely well. Hawks and vultures (Falconiformes) seem to be repelled, but do not respond as well as most other birds that were tested. Blackbirds (Icteridae) responded well except in roosts. One roost of double-crested cormorants (Phalacrocorax auritus) would not respond until pyrotechnics were used in addition to the test aircraft. Over half returned in spite of my efforts.

IV - DISCUSSION

4.1 - Advantages

A. Noisy aerial predator

These aircraft seem to do a good job of simulating a noisy aerial predator. Although equipped with a muffler, the screaming sound made by these engines

operating above 10,000 rpm does an effective job of moving the birds. Electric engines are available, but were not selected because of lower sound levels. Four-cycle engines are also available, but were not selected because of increased price and lower sound levels.

B. Habituation

There were no incidents of habituation observed. The longer the exposure to the aircraft, the greater the observed effectiveness. However, the longest exposure at a single site was three days. Most problems were solved after two or three sorties. Problems of habituation after long exposures to resident birds were not addressed by this study.

C. Control of flight direction

With these aircraft, it is possible to not only scare birds, but also to determine (to some degree) where they will go. The birds are scared up by the aircraft where they can be herded in a convenient direction and allowed to outrun the aircraft with judicious use of throttle and flaps. By not crowding or overflying these birds, you can keep them flying away as long as you can maintain good visual contact with your aircraft.

D. Increased area covered

Because these aircraft are mobile, one man can cover a much larger area than with conventional tools, especially in an aerodrome environment where the area is large and there are rarely any visual obstructions. Under optimum conditions, I believe a good pilot can cover 30-50 hectares which is similar to the results reported by Briot (1986).

4.2 - Limitations

A. Challenging to fly

These aircraft are a considerable challenge to learn to fly well enough to be effective on birds. Since you have no "seat-of-the-pants-feel", or instruments from the aircraft, you must maintain constant visual contact. Also, the more acrobatic aircraft will not fly "hands-off" for very long. It is difficult for the pilot to concentrate on

both the aircraft and how the birds are responding unless the conditions are ideal. Thus, the pilot's work load is high.

B. Endurance

Most R/C aircraft are designed to fly sorties of only 10-15 minutes. High performance R/C aircraft usually only fly 8-12 minutes per sortie. This requires landing frequently to refuel regardless of bird pressure. Standard battery packs only give 1-1.5 hours of flight time.

C. Weather

Weather is a major limitation in R/C aircraft operations. Wind greater than 20 knots is a major hazard to most trainer aircraft. They are slow and light and even moderate turbulence at ground level makes them difficult to launch and recover safely. Visibility is required and any weather that reduces the visibility reduces the pilot's effectiveness.

D. Maintenance

These aircraft require considerable maintenance. Batteries to run the ground transmitters and the airborne receivers and control servos must be kept charged. Spare battery packs must also be kept charged and handy. Wooden propellers easily break and carefully balanced spares must be available. The alcohol fuel is very destructive to the wood, so all surfaces must be carefully cleaned after flying. Balsa aircraft are delicate and after ruff handling or hard landings, repairs must often be made. Most of the maintenance costs depend on wages for personnel.

E. Cost

These aircraft are expensive. Current retail costs of similar kits in the U.S. are $100 - $150 plus another $50 - $75 for hardware, glue, coverings, etc. Construction time ranges from approximately 1 man-day to as many as 10 man-days depending on the complexity of the kit and the skill of the builder. Engines this size are $75 - $150 depending on quality. Radios are $200 - $250 and other required support equipment will cost $100 - $150. Thus, the costs for a single aircraft will typically run $500 - $800 at retail. Much of the equipment can be

ordered by mail at 20-35% savings. Since these aircraft must operate close to the ground most of the time, the probability of a major crash is always significant. Fortunately, the engines survive most crashes with only minor damage, and radios and batteries are almost never damaged.

V - CONCLUSION

Radio-controlled aircraft offer a useful and potentially effective tool for solving bird problems at aerodromes. Potential habituation/non-response problems could probably be eliminated by adding pyrotechnic launchers. Most limitations, except weather, are surmountable. Brightly colored aircraft will probably be better than raptor simulating models because of the improved visibility under most weather conditions. Due to length of time to train good pilots, personnel turn-over rates or availability of local hobbyists may influence the decision to use this technique. It needs to be a long term project to be cost effective.

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Prevention is better than legal liability

(Tim Scorer, London)

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BIRD STRIKES

PREVENTION IS BETTER THAN LEGAL LIABILITY

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The terms of reference of BSCE are necessarily predicated on the detection and prevention of the bird hazard to aircraft. In the search for increased safety in the air and on the ground considerable effort and expense is involved each year by airport authorities, aircraft manufacturers, aircraft operators and others in attempting to eliminate bird strikes. The effort and expense involved in bird control can also be justified when the safety objective has not been achieved and a bird strike takes place. When this occurs an airport operator may face a hazard of a different type in the form of a claim for compensation for death, injury or damage to property. While there have fortunately been comparatively few legal liability cases arising from bird strikes, the consequences of such a claim can have serious financial consequences to an airport operator and his insurers. This paper addresses those legal liabilities and how they may be avoided by the adoption of effective, efficient and well documented bird control procedures.

PRESENTATION

19TH MEETING BIRDSTRIKE COMMITTEE EUROPE

MADRID - 23-27 MAY 1988

When we last met in May 1986 at your 18th meeting I understood that there were one or two delegates who felt uneasy about having a lawyer present at your proceedings. As a result I came away from that meeting feeling a little bit like the "black sheep" of the family. I had accepted a very kind invitation to attend your meeting because at that time I was in the middle of some complex and expensive Court proceedings which had been taken against the British Airports Authority and the British Civil Aviation Authority arising out of a bird strike incident in Scotland. To some of you, I had explained that my purpose in attending your meeting was to be able to gather some of the considerable knowledge and experience among your delegates. I felt sure that this would be of assistance in connection with the defence of the Airport Authority in the Court proceedings.

I am very happy to report that my theory was correct and my efforts were not in vain. Towards the end of last year, the Claimants, a Swiss airline, who claimed about U.S.$350,000 from the Airport Authority and the CAA for repayment of the cost of repairing damage to the engines on their Learjet aircraft, eventually decided that the defence we had put up looked such that they would be unlikely to succeed in the case. Accordingly they filed Notice of Discontinuance of their action. Not only that, but we were able to recover a small contribution towards the legal fees incurred in fighting off this claim.

First therefore, I must express my very sincere gratitude to all of you for the words of wisdom which you handed directly and indirectly to me during that meeting in Copenhagen. The papers which I obtained, the presentations which I heard and the discussions which I had with many of you proved to be immensely valuable in presenting what was a formidable defence to the claim, assisting me to establish, I think beyond reasonable doubt, that the system of bird control at BAA Airports on that occasion had been totally satisfactory and as much as anyone could reasonably expect. The litigation itself taught me a great deal. I remember with great affection spending two dawn inspection trips in a Landrover on a very cold winter's morning in Scotland, seeing bird control in action and finding out about how to minimise the risk of birds causing serious damage to aircraft or worse still injury or death to the aircraft occupants. In the course of my enquiries I visited a number of other airfields, particularly two military airfields operated by the Royal Air Force (thanks to Crawford Turner) where they had engaged an independent bird control contractor whose knowledge, efficiency and system of bird control very much impressed me and was, from the results obtained, most satisfactory in its execution. Also may I express again my sincere thanks to all of you who completed the questionnaire about the law and practise in your various countries concerning legal claims arising from bird strikes.

Now, as a Director myself of an Airport Authority, I am now faced with a new case involving considerable damage to a turbo prop aircraft as a result of a bird strike. In contrast to the international BAA Airport, I am now dealing with a small provincial airport with grass runways, one scheduled service operating four times each day, and many small aircraft engaged in flying instruction, club touring and private and business flying at the lighter end of the scale. The requirements for bird control are very different to the international airport and mainly because of the speed of aircraft using the small airfield, and the fact that they are not jet aircraft, the risk of bird strikes causing serious damage, injury or death, is that much less. But the technique is just the same and the

In fact the Controllers on the ground knew nothing of this until many minutes later when the aircraft, which had by then reached a height of about 11,000 feet en route to Geneva, radioed that it had an engine problem and the pilot said he suspected that a bird strike had taken place. The Captain was asked if he was aware of any damage to his aircraft. His reply to the Controller was "I don't know but there is a funny smell of burning chicken"! The aircraft returned to Prestwick and certainly showed signs of bird damage on the leading edges and around the engines. Inside the engines some of the turbine blades and compressors were also badly damaged leading to a total repair bill of about U.S.$350,000. The aircraft insurers subsequently issued a claim against the Prestwick Airport Authority alleging that it had failed to properly carry out its bird control function and that if it had done so then the bird strikes would not have occurred. A claim was also made against the U.K. Civil Aviation Authority that its Controllers had cleared the aircraft when it was not safe to do so and that they should have detected the birds which were in the vicinity of the runways and should have warned the pilot that it was unsafe to take off.

The origin of the flock of plovers was in some doubt although it was not in doubt that they had hit the aircraft. Where had they come from? The pilot in his initial comments to the Airport and in the filed occurrence report did not seem to have seen them at any stage or even to have been aware that his aircraft had suffered a bird strike. In the occurrence report completed by the pilot after seeing the remains of the birds in his engines, he actually stated that the strike had involved gulls not plovers. If he had been aware of the bird strike, why had he not immediately reported it over the radio and returned straight back to the airfield? To continue his en route climb to 11,000 feet with no report surely indicated that he was not aware of the strike. However in the Court papers that followed two years later, Aeroleasing claimed that the pilot had actually seen a flock of plovers rise up from the grass at the edge of the runway on his left, had watched them hesitate as they flew away from him but then had seen them return swooping low over the runway in that classic plover style and across the path of the rotating aircraft.

The Air Traffic Controllers saw no birds near the runway and both they and the Airport Authority said that it was quite likely that the birds had actually been loafing in a field outside the perimeter fence about 100 metres away from the runway area where the aircraft rotated. The evidence for the Airport Authority therefore centered on the following questions:-

1) Would it have been likely that a flock of plovers would be loafing or feeding by the side of a runway that was in use regularly by light aircraft even though most of them would have rotated and been airborne well before the point where the Learjet rotated? Or was it more likely that the plovers had been airborne for some time from a point much further from the runway and had coincidentally been flying low over the runway just at the moment when the aircraft was there?

2) If the plovers were loafing/feeding in the grass should or could they have been seen by the Air Traffic Controllers and/or the Manoeuvring Area Safety Unit (MASU) of the Airport Authority who were out in their landrover on general duties ensuring the safety of the airfield and its users? If the plovers were flying towards the runway and the aircraft, should/could ATC have seen them and if so what could they have done to prevent the aircraft hitting them?

3) What was the system of bird control used by the Airport Authority and was it adequate? What vehicles, equipment and manpower were available to carry out bird control and how much time was spent on that activity?

environment, will render the airfield operator liable under civil law to make compensation to those who suffer loss as a result of the airport operator's failure.

In other words, in the context of bird control, it could be said that not only is it desirable that there should be a safe environment in which aircraft can operate, but it is in fact essential, if civil liability at law is to be avoided, that an airfield operator adopts certain procedures and can demonstrate that he exercised those procedures at or before the time when an aircraft suffers a bird strike on that airfield. A failure to exercise proper care will expose the airfield operator to liability. The fact that he thinks he has carried out his responsibility, will not assist him in the event that a Court of law disagrees.

A further factor that compounds the problem comes about in this way. Most international air transportation and a sizeable amount of domestic air transportation within the boundaries of the same State, are subject to limits on the liability which faces an aircraft operator who operates public transport flights on which passengers are carried. For example, under the Montreal Agreement of 1959 a non U.S. air carrier operating to or from the U.S.A. is required by U.S.A. law to enter into a special contract with passengers to the effect that the liability of the airline in the event of injury or death is limited to a sum of U.S.$75,000 inclusive of legal fees. Similarly the United Kingdom CAA requires that U.K. registered airlines should enter into special contracts with their passengers providing compensation to a minimum level of the equivalent of 100,000 Special Drawing Rights. Although this is a minimum limit obviously every carrier restricts their liability to that sum. Where no specific limit is provided by the legislation of a country, then the prospects are that that country is a signatory or has notified its adherence to the Warsaw Convention of 1929 usually as amended by the Hague Protocol of 1955. This Convention and Protocol also provide minimum (maximum) limits for air carriers towards their passengers. The purpose of the Convention and Protocol were of course originally to ensure uniformity of compensation across the world as between airline passengers travelling between different States. The limit provided for passengers is not very large by modern standards being in most cases a maximum equivalent to U.S.$20,000. It would take the duration of this Conference to look at the matter in any more detail but I hope this summary will suffice.

The point of what I am saying is this. If the entitlement of a passenger or his dependants to recover damages from an airline operating an aircraft in which the passenger is killed or injured, is limited to a specific sum then provided the airline has not been guilty of wilful misconduct or recklessness in the piloting or handling of the aircraft, the passenger or his dependants can recover no greater sum from the airline. Of course in most cases, the level of compensation to which the passenger or the dependants would ordinarily be entitled to but for these limits is considerably higher than the limits. This means there is usually a very substantial shortfall in the compensation level. Because the compensation level only applies to the airline and not to any other body, such as a manufacturer, an Airport Authority, an Air Traffic Control Unit or anyone else, it is not unreasonable to suppose that injured passengers or the dependants of dead passengers will be looking for someone else to sue to recover more compensation. If the injury or death occurs as a result of a bird strike to an aircraft and that bird strike has occurred because of a lack of proper procedures, a lack of adequate bird control or a failure on the part of the Airport Authority to take reasonable steps to prevent the bird hazard, then that Airport Authority is liable to face litigation from and on behalf of passengers.

The message that I want to put over to you therefore in this short presentation is this. As someone who has been acting for Airport Authorities both in the U.K. and abroad for some time now, it is becoming increasingly clear that proper bird control at airfields is not only desirable from the point of view of the safety of the air travelling public - a very good reason in itself - but is also a potentially serious financial liability on the Airport Authority and Air Traffic Control services. Unless there exists a situation where the Airport Authority and Air Traffic Control services enjoy some form of immunity from legal action, then they are liable to face claims for substantial compensation by those who are injured or killed as a result of the failure to maintain a proper system of bird control. They may of course also face claims for property damage, such as the U.S.$50 million loss of the jumbo jet if it suffered a total loss.

From time to time responsible Airport and Air Traffic Control Authories seek guidance as to how they might best fulfill their functions and be able to demonstrate that the bird control system in operation at a particular airfield at a particular time when a bird strike takes place is a safe and satisfactory system and one which demonstrates that insofar as it is possible in all the circumstances, the Airport Authority took every possible step to eliminate the bird hazard.

In England in 1979 we had a major case (Fred Olsen Air Transport Limited v. Norwich City Council and Norfolk County Council, High Court, Queens Bench Division (unreported)) involving Norwich City Airport against whom a claim was made by the insurers of a charter aircraft which was seriously damaged when its take off had to be aborted and it landed in a field beyond the airfield with considerable damage resulting. The Judgment issued in the High Court in England following that claim provided useful guidelines as to the steps which should be taken by a competent and responsible Airport Authority to prevent the bird hazard. Some of you may be aware of the facts of this case but for those who are not perhaps I can give a brief outline.

The action was for the recovery of the value of the hull of a Dassault Fanjet Falcon when it was damaged beyond repair after the forced landing on 12th December 1973. Shortly after take off the aircraft encountered a large number of gulls some of which were ingested into both engines causing them both to stall. The Plaintiffs alleged that the gulls had risen up from the runway or its adjacent areas into the flight path of the aircraft very shortly after take off. They said that for many years up to 1973 it was universally recognised that birds were a serious hazard to jet aircraft. They alleged that the Airport Authority had a defective system for discovering the presence of gulls on the airfield and dispersing them, that the Air Traffic Controller allowed the take off when it was unsafe to do so because of the gulls, that substantial parts of the airfield were invisible to an observer in the control tower, and that because of the time of day, the state of the weather and the condition of the windows in the control tower, the Air Traffic Controller could not have had a proper view of the airfield.

Much of the evidence involved the types of devices available to airport owners to dispel birds, the tendancy of gulls to congregate at Norwich Airport particularly in bad weather when they came in from the North Sea and of course whether the gulls actually came from within the airport or without. The Airport Authority in defence alleged that the flight crew had failed to see and avoid the birds. The Judge found that in 1973 there was a reasonably foreseeable risk of damage to aircraft from the presence of gulls at Norwich Airport. It was reasonable that the Air Traffic Controllers, who were employed by the airport, should keep a proper look out for the presence of gulls which might cause a risk to aircraft and that the duty to keep a look out continued not only up to the time when the

aircraft was given clearance to take off, but at least until it started its take off roll. In this case a period of about 1½ minutes had elapsed between the giving of the clearance and the commencement of the take off roll.

The Judge also found that at the time of the accident, visibility from the control room was affected by condensation inside the windows and water droplets on the outside and that these factors were aggrevated by the approach of darkness. It was also clear from the evidence that an observer in the control room could not properly see the surface of the runway and in particular the area at the western end. Since the only way round this problem was resiting the control tower, this placed an additional burden on the Airport Authority rather than giving them an excuse, because it was even more essential that they should have an effective system for discovering the presence of gulls on or near the runway and for dispersing them. The Court also heard that the U.K. Bird Impact Research and Development Committee had been set up in 1965 and had published a booklet in 1969 entitled "Bird Control on Aerodromes". This publication, together with official statistics of bird strikes which had been reported since the inception of a reporting scheme in 1966, indicated that there was a well recognised risk of injury and damage to aircraft due to bird strikes particularly in the case of ingestion of birds into jet engines.

The booklet "Bird Control on Aerodromes" had contained a list of recommendations to airport operators. These included:-

a) Growing long grass to discourage the presence of gulls

b) Detection of birds by reference to preferred areas at times of day and night when bird movement and congregation could be expected.

c) Maintenance of a continual watch from the control tower, supplemented as necessary by continual patrols of the operational area.

d) The publication also said "An inspection of the runway should always be made before each take off or landing if more than 15 minutes had elapsed since the previous aircraft movement or since the previous inspection".

e) The use of a bird distress call system (SAPPHO) and the use of shell crackers.

f) The maintenance of a bird action log recording the daily movements of birds.

The Judge found that the rate of bird strikes at Norwich was sufficiently high for the airport to have appreciated that there was a serious problem from the presence of birds at the airport. He commented "Had the Defendants followed the recommendations they would have discovered the presence of the gulls and would have dispersed them and this accident would have been avoided." The Judge accepted the Plaintiff's allegations that the system in use at Norwich Airport was "haphazard and lax". Had the Defendants adopted a more vigorous approach to the problem their employees would have realised that it was of the utmost importance to survey the airfield for gulls before giving clearance and permitting an aircraft to start its take off roll. An essential part of the duty to exercise reasonable care was that the airport authority would carry out inspections when there were conditions of bad visibility.

On the other hand the Judge did not think that the pilots could be blamed for not having seen the gulls. The time of a take off roll is a time of intense preoccupation by the flight crew and given the speed at which the aircraft was

moving forward, the state of the light and the weather, the colour of the runways and the size and colour of gulls, the flight crew could not have been expected to see them. They had received no warning even of a general nature about the particular hazard at Norwich and the Judge condemned the Airport Authority for failing to exhibit a notice calling attention to the bird hazard. The Judge doubted whether in all the circumstances the crew could or should have abandoned the take off if they had seen the gulls and accordingly the crew were not found to be negligent. Judgment was given against the Airport Authority.

Arising out of this case and the guidelines mentioned in the Judgment, the U.K. Civil Aviation Authority published CAP 384 entitled "Bird Control on Aerodromes". This publication appeared shortly after the publication of DOC9137-AN-898 by the International Civil Aviation Organisation entitled "Airport Services Manual - Part 3 Bird Control and Reduction". This latter publication recited the principles of Annex 14 of the ICAO provisions by which it was stated that there is a need for States to adopt measures as necessary for discouraging the presence on or in the vicinity of an Airport of birds constituting a hazard to aircraft operations. The purpose of the Manual was to provide assistance to States in ensuring that adequate measures were taken to overcome potential bird hazards. I am sure that you are all familiar with this Manual but perhaps I might be permitted to draw your attention to certain specific facts which really bear out what I have said above.

In a perfect world, if an Airport Authority faced with a bird strike is able to point to the Manual and say in all honesty that they complied with all the recommendations and advice in the Manual, then it is highly unlikely that they would face any exposure to legal liability. However unfortunately we do not live in a perfect world and the day to day practicalities of financial constraints, shortage of manpower, human error, a sound previous record and other factors all militate against the adoption of the Manual and its recommendations on a 100% basis. I am sorry to say that, on a number of occasions, when asking how it was that certain advice in the Airport Services Manual or in the CAA publication CAP 384 had not been followed, I have been told that it would be financially ruinous for the Airport Authority were it to adopt all the recommended measures. By way of last resort, the Airport Authority points to the fact that up to the time when the bird strike in question took place, the airport had a good record with no significant bird strikes and no previous problems. Bird control is rather like making a last Will and Testament. You do not have to have it but if you leave this earth without having made a proper Will you should not be surprised if your Estate is distributed in a way that was contrary to your real wishes and was carried out in a somewhat haphazard way. With bird control, the effective organisation and implementation of the system often does not become apparent until a bird strike has taken place.

In the case in which I was involved at the time of Copenhagen, the facts were these. On 4th November 1983 at Prestwick Airport, Scotland, a Learjet was taking off from runway 21. This was the minor of the two runways - the other being 31/13 which was the main ILS runway. Due to the configuration of the runways, it was possible for both to be used almost simultaneously. So since the airfield had a mix of traffic, some large international flights and a lot of training and light aircraft flights, on this day, due to the wind direction, smaller aircraft were using 21 and larger aircraft 31. The Learjet operated by Aeroleasing SA of Switzerland needed an expedited departure so the Controller cleared the aircraft to use 21 instead of 31 which was awaiting the arrival of a transatlantic flight. After clearance the Learjet started its take off roll. As it reached rotation speed, a flock of golden plovers appeared in front of it and it flew through them suffering a multiple bird strike.

criteria are just as important. Bearing in mind the budget of the airfield operator, the nature of the traffic using the airfield, the geographical position of the airfield and the available resources, what reasonable steps can be taken to prevent birds being on the airfield where they might present a hazard to aircraft using that airfield?

For a moment may I digress from the theme that I am building up? It was very clear to me at Copenhagen that the overriding themes of the meeting were:-

1) how to prevent birds becoming a hazard to aircraft; and

2) how to reduce the impact in financial terms of a bird strike which takes place.

Let me give you an example. In the case of military airfields owned by the Government, operating military aircraft that are flying on behalf of the Government, the principal criteria are:-

a) avoiding injury and loss of life to highly trained military pilots and other personnel on the military airfield; and

b) avoiding the loss of highly expensive, technologically advanced aircraft which form part of the strategic defences of a country.

The theme continues into the civilian world. Birds on airfields can represent a hazard to civil aviation and all who use it. When a bird strike occurs to an aircraft, it threatens the safety of that aircraft and the safety of the passengers and crew within it. Injury to life and limb are something on which it is impossible to place a monetary price. Therefore any steps that can be taken to preserve life and avoid injury are steps well taken and are steps which should be taken by every competent and responsible Airport Authority throughout the world.

However, in the case of potential damage to aircraft, in theory there is no doubt that this should also be avoided but predominantly it has to be avoided because a damaged aircraft obviously affects the safety and security of those within it. An aircraft whose means of propulsion and flight are threatened by a natural phenomenon is a less safe aircraft and one whose passengers are at greater risk of death or injury. From the point of view of the cost of damage or loss of the aircraft itself, ignoring the passengers within it, there is somewhat less concern. After all, anyone owning an asset worth say U.S.$50 million is clearly going to take reasonable steps to insure that aircraft against loss or damage so as to ensure that they are entitled to be indemnified if the aircraft is damaged or suffers a total loss.

May I now introduce a further very significant factor to you? It was evident from the questionnaire which I sent round at the Copenhagen meeting and to which most of you very kindly replied, that in quite a number of countries an Airport Authority does not necessarily or has never yet had to face a potential liability for claims by an aircraft operator, crew member or passenger, in respect of loss, death or injury suffered as a result of a bird strike on an airfield. The effect of this, is that the airfield operator takes whatever steps he regards as reasonable to prevent bird strikes. Whether those steps do amount to reasonable bird control are never likely to be tested. If the steps the airport takes should be found insufficient, compared to the standards of other airports, then this is of no consequence because that airfield operator does not face an exposure to civil liability as a result of his shortcomings. Unfortunately the same does not apply in countries such as England, Holland and the U.S.A.. In these countries, the failure to exercise proper care in bird control at an airport and its

What did the MASU have to do on the airfield apart from carrying out bird scaring? What training and instruction did the MASU personnel have in relation to bird scaring? What records were kept of bird patrols and bird sightings? What system of inspections was used at Prestwick and how often were they carried out, for what duration and with what result? What steps did the Airport Authority take in relation to particular characteristics of their airfield, such as its proximity to the sea, to a caravan site with a rubbish dump and to a bird sanctuary as well as its position close to a major bird migratory route? How did they deal with birds on the airfield and were their systems up to date and effective? (It is no use having a tape of the warning cry of a starling if you have no cassette player to broadcast it!)

4) What did the records show about the level of bird activity and bird strikes at Prestwick compared with other similar airfields in the U.K. and abroad? In fact Prestwick was able to show one of the lowest bird strike rates for movements. This evidence helped to show that their methods were effective especially when the other factors such as location were taken into account.

The potential danger to the Airport in this case was the fact that although the system looked good and appeared to have been properly adhered to there was evidence that at the time of the bird strike the MASU landrover driver was at the far end of runway 31 looking after some contractors who were replacing lights just off the end of that runway. While he was needed there to move the contractors when an aircraft was taking off or landing, the claimants said he should have been patrolling runway 21 to keep it clear of birds so that their Learjet was safe. However since the ATC tower was closer to this runway and a Controller with binoculars was capable of seeing the whole length of runway 21 quite clearly, we said it was not unreasonable that ATC should look after that runway while the MASU looked after the contractors on the other runway.

In most litigation wherever it takes place there is a duty on each side to disclose all those documents which have any bearing on the case whether those are helpful or unhelpful documents. The process is called "discovery" and the extent of it varies from one legal system to another. As a general guide in a case such as ours involving Prestwick, it was necessary to produce general records going back some years and detailed records for the year up to the accident and thereafter. The records included the airfield log books of inspections and patrols, records of earlier bird strikes, annual reports on Prestwick Airport, CAA annual statistics on bird strikes, airport manuals, airport instructions, work rotas, shift rotas, vehicle maintenance records, cartridge purchase invoices, staff training reports, staff assessment reports, movement logs and a whole series of other documents that had long since reached the BAA archives.

Of course all this is the lawyers' province - or is it? The keeping of proper records is essential to maintaining a proper system of bird control. It has been very clear to me that so much of your work is related to research and analysis of records and statistics. Man cannot control the birds save to a limited extent. But by monitoring their activities on a regular basis and noting seasonal, geographic and demographic changes he can with some reasonable accuracy predict what birds will do and when. It is only by having statistics properly analysed that he can do this. Armed with this information man can then determine trends and tendancies of bird behaviour so that it becomes not a guessing game but more of a scientific probability. Those same records that equip him to fight off the bird hazard also become weapons in the fight before a Court of law. There is no

doubt that our success in the Prestwick case was substantially due to the fact that we were able to prove a proper system of bird control at Prestwick and a proper adherence to the system by the responsible personnel.

In the final analysis everyone has to accept (a) that it takes only one bird to create a bird strike and (b) that it is impossible to empty the ground and the skies of birds every time an aircraft takes off or lands or flies - they got here first after all! But in this world of legal claims and recovery of compensation, it is no longer enough to leave the birds to roam freely and to put down horrendous aircraft accidents to "an Act of God". Case histories from around the world have now established that it is "An Act (or omission) of man" if he fails to take reasonable steps to ensure that the airfield he operates, and to which he invites visiting aircraft, is as free as possible from the bird hazard and that he has taken all reasonable steps to ensure that when birds fly and man flies, the two do not meet.

For reasons of time and space I have not addressed the liabilities arising from the bird hazard which can rest on flight crews, manufacturers of aircraft or, except in general terms, Air Traffic Controllers. All these bodies have their own potential risks which can impose liability on them. They also have a potential obligation to make financial recompense to those who are injured or killed or who suffer property damage as a result of their negligence. As a simple example, a pilot who is warned of the presence of birds loafing on the runway and asked to hold his take off until a bird run has been carried out, but who nonetheless continues with the take off, cannot be heard to blame the Airport Authority for having an inadequate system of bird control. On the other hand the promulgation in aviation publications, such as the U.K. Air Pilot, of warnings about the bird hazard in relation to certain specific airfields, cannot impose on aircraft operators a total liability for the safety of their passengers without regard to whether or not there is adequate control of birds on the airfield. Such a promulgation can only act as a general warning to make pilots particularly aware of abnormally high risks from the bird hazard. It cannot serve to remove the liability of the airport operator to maintain a proper safe system of bird control.

Finally I have not covered another aspect of the Prestwick case which I believe was quite significant in determining the claimants to withdraw their claim. This is the question of rights and obligations incurred by a contract. It was clear from the evidence that when the Aeroleasing pilot landed his aircraft, he signed a form of agreement to pay landing fees and also on behalf of his company he agreed to be bound by the standard BAA Terms and Conditions of Use of Airports. One of those terms and conditions contains an exclusion of liability on the part of BAA in respect of any damage to aircraft, loss of life or injury which may occur as a result of anything happening to the aircraft in the course of landing, taking off or manoeuvring at the BAA Airports. Conditions such as this are often seen in airport Terms and Conditions of Use. Some have a greater legal effect than others. In the U.K., clauses of this nature are subject to a test of reasonableness before the party against whom the exclusion is claimed can be held to be bound by it. Courts will therefore look at all the circumstances surrounding an incident such as this as well as at the contractual wording and will make a determination as to whether or not it is reasonable that the Airport could exclude its liability to the aircraft operator. In the Prestwick case again we felt that our prospects of the exclusion being upheld were good but it would not necessarily be so in every case. Subject therefore to advice from lawyers as to the application of such a clause in any particular legal jurisdiction, it is generally a helpful provision to insert in a contract between an airport and an aircraft operator because it may give the airport operator a way out of liability that would otherwise rest on him arising from a bird strike. Obviously it is

better that such a clause is in a contract than that there is no such clause. I have to say though that if there was clear evidence that an Airport Authority had taken effectively no steps at all to deal with the bird hazard or had a very lax system that was poorly documented, the fact that they had an exclusion clause in their contract may not assist them and the clause would be held by the Courts to be unreasonable.

I sincerely hope that this short presentation will be useful to you in your activities and will be constructive towards preventing your own authority becoming involved in claims such as those I have mentioned. If what I have said is helpful in any way it cannot be more well received than the hospitality, friendliness and above all wise advice which I received in Copenhagen from many of you. The thanks are all from me - and I am indeed delighted to be able to extend them to you today.

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The use of synthetic noise generators in French airports

(J.L. Briot, France)

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The use of synthetic noise generators in French airports

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FRANCE

Abstract:

This paper summarizes seven years of research in France with different noise generators. The latest type of equipment manufactured in France is described. Visual observations and birdstrikes are analyzed, the results discussed and the future considered.

I - Test chronology

This chapter gives a very brief summary of the various tests conducted since 1981 with noise generators of different types:

1981: Test of the "Avalarm" ST4 model

1982-1983: Test of the "Avalarm" ST100 B2 model at LFPG. Original equipment comprises 2 loudspeakers on a mast, powered by a 30 W amplifier (Photo 1).

1984-1985: Increase in the emission power of the Avalarm ST100 B2 by addition of a 240 W amplifier powering 7 loudspeakers located every 150 m, 80 m from the edge of the runway. Test at LFPG in winter on two 900 m sections of runway.

Study of a prototype synthesizer conducted by the Centre National de la Recherche Scientifique (CNRS) capable of producing digitized distress calls and Avalarm type signals.

1985-1986: Installation of a line of loudspeakers covering two thirds of runway 07/25 at LFPO, powered by 2 Avalarms and three 240 W amplifiers (photo 2).

Comparison with a hawk experiment at LFPG.

Tests with digitized distress calls from a vehicle.

1986-1987: Manufacture of a preseries of 10 French synthesizers

Definition of the equipment required to broadcast the biological or artificial signals over a full runway.

Installation of noise generators on 2 runways at LFPG, 1 runway at LFBD, 1 runway at LFBT and 1 at LFPO (photos 3,4,5)

Test of biological and artificial signals on these airfields.

1987-1988: Installation of noise generators on 1 runway at LFMN and LFRJ.

Doubling of the number of loudspeakers at LFPG.

Study of the reduction in the problem brought about by these noise generators.

Series production of fixed and vehicle-borne noise generators (Photos 6,7)

II. Results

II.2 Bird observations

The first tests conducted with the Avalarm ST4 gave disappointing results for both lapwings and gulls.

Birds were observed in front of the working loudspeakers. The reasons for this failure were probably the signal spectrum, the very low emission power (10 W) and the poor efficiency of the loudspeakers used.

Initially, the Avalarm ST100 B2 posed considerable problems since the manufacturer provided no instruction manual. After a large number of tests with the original item, the following observations were made with lapwings (V. vanellus) in winter at LFPG:

- the best results, characterized by the number of lapwings on the ground around the loudspeakers, were obtained with a low frequency and high emission rate (30 seconds of emission for every minute of silence),
- addition of a blaster did not give better results,
- the area covered is about 100 m in front of each source,
- there is no habituation and the same signal can be played at the same rate for several days in a row.

Broadcasting this type of signal over sections or complete runways confirms these results at Roissy and Orly:

- When the loudspeakers are working, the lapwings and gulls settle behind the speakers or in areas which are not covered by them,

- only 1 to 5% of the bird population frequenting the edges of the runways can be observed in the grass in front of the loudspeakers, in particular when the wind conditions are right, and even then in areas where the noise is lowest (between two loudspeakers),

- as soon as the broadcast stops, the birds gradually come back in front of the loudspeakers and right up to the runway (no difference after 2 hours stoppage),

- certain individuals sometimes land on the runways in front of a loudspeaker which is working. They tolerate one or two emissions, but remain wary and uncertain and always finish by flying away,

- birds in flight which cross the runway almost never react and at best gain height slightly (woodpigeon).

The commissioning of French synthesizers capable of playing several types of signals and the installation of high performance loudspeakers along the complete runway has led to the following conclusions:

- to worry the birds, the signal broadcast must be non-harmonic and have a high acoustic level over the entire area to be covered (80 dBA along the runway axis),

- this signal must comprise two noises lasting 150 ms, with a spectrum centered on 3 unharmonic frequencies($f1=2150Hz,f2=1,8f1,f3=2,95f1$) see appendix

- if the periods of silence are too long, birds can return between two emissions, 30 seconds of signal for one minute of silence seems to be a good rate,

- the level of background noise, the height of the loudspeakers, their performance, their directivity curve and above all their position in relation to the prevailing winds, are extremely important factors with this type of signal, which must be clearly distinguishable from the background noise if it is to be effective,

- finally, these artificial signals proved to be effective on lapwings (V. vanellus), Black headed-gulls (Larus ridibundus), and woodpigeons (Columba palumbus). However, they would appear to have no effect on birds of prey (Milvus migrans, Falco tinunculus), gallinaceans (Perdix perdix) crows (Corvus frugilegus)and starlings (Sturnus vulgaris).

The comparison between the biological signals (synthesized distress calls) and the natural signals was made by the CNRS and our department. There appeared to be no significant difference between the reactions of the birds to the synthetic signals played by a synthesizer and the natural signals recorded on magnetic tape (see appendix 2). These comparisons concerned the black-headed gull (L. ridibundus), the herring gull (L. argentatus), the lapwing (V. vanellus), and the starling (Sturnus vulgaris). An inter-species signal giving good results on these 4 species, plus the rook (Corvus frugilegus) was also created by the CNRS (appendix 3). The attraction of the birds to the sound source (positive tropism) is less marked with this signal than with the natural signals.

The emission of these biological signals from loudspeakers installed along the runways poses two types of problems:

- if they are played too often, even if irregularly, the phenomenon of habituation appears,

- automatic broadcasting, irrespective of air traffic, is extremely dangerous. This results in hundreds or even thousands of birds taking wing at the same time, even if settled far from the runways, which could interfere with aircraft movements.

These signals should therefore be reserved for manual triggering at appropriate moments during lulls in traffic:
- either from loudspeakers installed along the runways to clear the verges,
- or from a runway vehicle linked up to the control tower to carry out isolated operations on clearly identified groups of birds.

III - Birdstrike statistics

Birdstrike statistics are always open to criticism and difficult to interpret owing to the many factors involved:

- the way in which information is collected varies from one year to the next (the more attention paid to the bird risk on an airfield, the more collisions are discovered through the number of dead birds found on the runways, for example),

- years are never the same from an ornithological point of view, owing to the meteorological variations recorded from 1 winter to the next,

- the number of events on which the statistics are based are low after elimination of those cases in which the runway, the time and the altitude are unknown.

Nonetheless, a study of the tables given in appendix 4 identifies some encouraging trends:

- the number of incidents resulting in damage has fallen from 11 per year at LFPG, LFPO, LFBD (average obtained between 1984 and 1986) to 1 per year in 1987 on the runways equipped with noise generators. This single incident was in fact recorded on runway 10/28 at LFPG whose installation proved to be defective this winter (many loudspeakers unserviceable). The number of serious incidents has either not varied or has increased on runways not equipped (such as Orly). These serious incidents have always been well logged,

- the total number of birdstrikes recorded on the ground over the three airports has gone from 21/year to 7/year on the runways equipped with noise generators (2 with partridge, 1 with a rook, 1 with a gull and 3 with unidentified birds),

- the number of birdstrikes recorded at above ground level has not changed (46 before the scarers, 44 after).

Unfortunately, the situation at Tarbes (LFBT) has not changed regarding the Black Kite (Milvus migrans) showing either that this signal has no effect on this species, or that there is a lack of power on the runway linked to that the fact that the loudspeakers are lower, spaced too far apart (200m)and less powerful.

IV - EQUIPMENT USED

Two equipment assemblies are currently available:

- for airfields on which installation of noise-generators along the runways is not envisaged (few birdstrikes, problems with local inhabitants, etc.), one or two runway vehicles (or SSIS) are equipped with "mobile" synthesizers. This extremely practical vehicle-mounted system comprises 1 CSSE synthesizer capable of playing 4 specific distress calls and 1 multi-species call, 1 AMD 30SB/M amplifier of 30 Watts. It is powered by the vehicle's 12-volt battery. The technical characteristics of the equipment are given in appendix 5(photos 6-7)

- equipping a 3600 m runway with fixed noise-generators requires the following equipment: 1 rackable CSSE synthesizer powered with 220 V, set to the alternating signal position, 3 240 Watt amplifiers, 48 30 Watt loudspeakers, Hpc 40T, 24 masts of 2.5 m, 4000 m of two-wire 2 x 4 or 6 mm² cable (see appendix 6). Spares, an on-off remote control, a programmable startup clock, and a loudspeaker lines remote monitoring system (included in the AMS 240 amplifiers) must also be provided. The installation control and monitoring decks can be installed in the runway offices or the control tower (photo 5). A temporary installation can be made using cable laid on the ground but line breaks are frequent (mowing, rabbits!). A correct and definitive installation requires that the cables be buried, which can be carried out at lower cost if advantage is taken of a runway lighting renovation operation.

V - Discussion

The advantages of using fixed noise-generators can be summarized as follows:

- the cost-efficiency of the method is highly satisfactory (heavy investment to start with, negligible subsequently),
- the method is automatic, works in all weathers (except for violent winds blowing straight into the loudspeakers), from sunrise to sunset. It guarantees a certain degree of safety all year round without any need for intervention by the airport personnel,
- the equipment used is extremely reliable (only a few loudspeaker failures have been recorded with the first series, which has now been modified),
- the method is effective against a large number of species which constitute a danger for air traffic (gulls, lapwings, pigeons),
- it is well-adapted to French legislation which in priority requires removal of birds located on the runways. The State or the Managing Authority cannot be held responsible for birdstrikes which occur in the air,
- finally, the broadcasting of digitized distress calls during traffic lulls means that all the birds on the verges can be scared quickly and all at once, even far behind the loudspeakers.

The main drawback of this method is linked to the sound pollution experienced by persons located on either side of the noise generators (personnel working on the runways, fire brigade, or even outside the airport perimeter). The noise measurements show that the nuisance created by the signal depends on the direction of the wind, even at 250 m behind the loudspeakers (emergence of 5 to 10 dBA).

To limit this nuisance, the following steps must be taken:

- the number of sound sources must be increased to provide better distribution of the signal along the runway while at the same time reducing the emitted noise (appendix 7)
- the loudspeakers should be installed lower (40 cm above the ground) to increase absorption by the ground and reduce the effect of the wind),
- noise screens should be installed behind the loudspeakers (photo 8 and appendix 8).

An installation of this type comprising 75 loudspeakers is being set up on runway 08-26 at Orly. We will have to wait until next winter to see whether this new layout changes anything regarding the results obtained with the birds.

The second drawback lies in the fairly limited surface covered by the loudspeakers (the runway ± 45 m depending on the wind). When thousands of gulls and lapwings are present on the platforms just behind the loudspeakers, the crews can feel it necessary to abort take-off, even if there has been no collision, in particular if the birds are disturbed (security patrol, very noisy aircraft, fox, etc.).

In periods of intense bird activity, it is therefore necessary to use either conventional bird-scaring methods or to broadcast specific distress calls with noise-generators during lulls in traffic.

Finally, the third drawback is linked to the bad results obtained on birds of prey and gallinaceans, which should be improved, at least at LFBT, in 1988, by the installation of equipment with higher performance, thus avoiding the more costly incidents. It will nonetheless be necessary to retain the option of using more conventional bird-scaring methods (distress calls, pyrotechnics, hunting) during the periods of intense bird activity, using a small number of well-trained personnel.

In 1988, the equipping of a new runway at Orly, the doubling of the number of loudspeakers at Bordeaux, Nice, Roissy and Tarbes should improve even further the results obtained, as well as defining the effect of the method on other species (herring gull - Larus argentatus, and Black Kite - Milvus Migrans).

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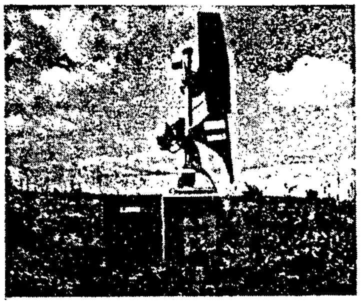

AV ALARM ST 100 B2 MODEL

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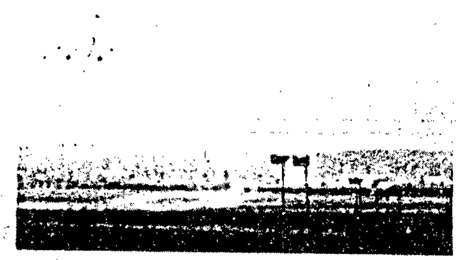
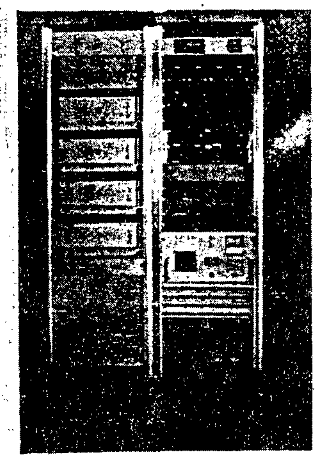


FIRST LINE OF LOUDSPEAKERS AT LFPO

3



EQUIPMENT USED FOR ONE RUNWAY

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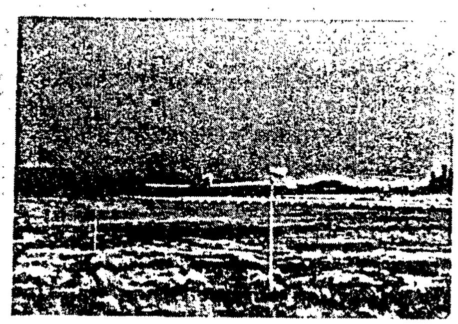

LAST LINE OF LOUDSPEAKERS AT LFPO

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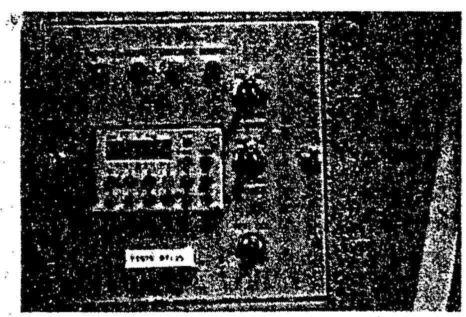
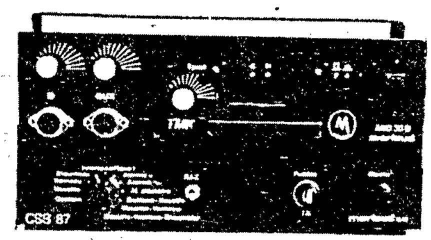


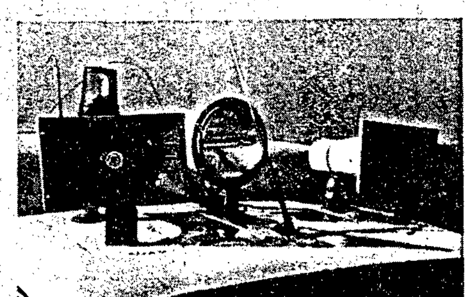
MONITORING DECK

6



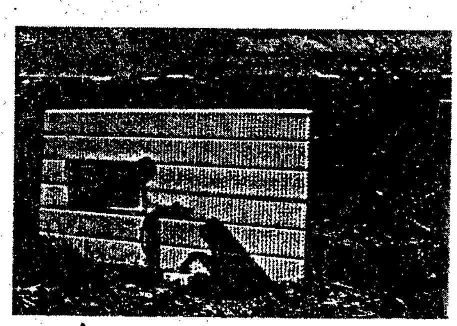
MOBILE SYNTHESIZER

7



ON BOARD LOUDSPEAKERS

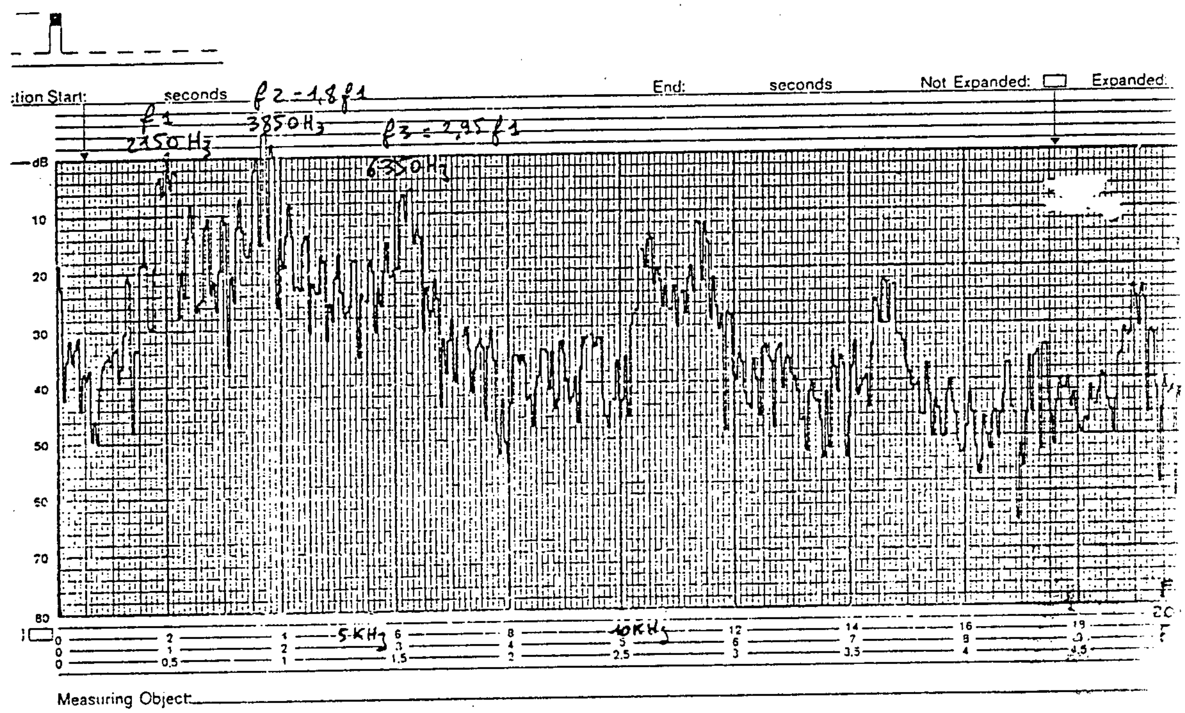
8

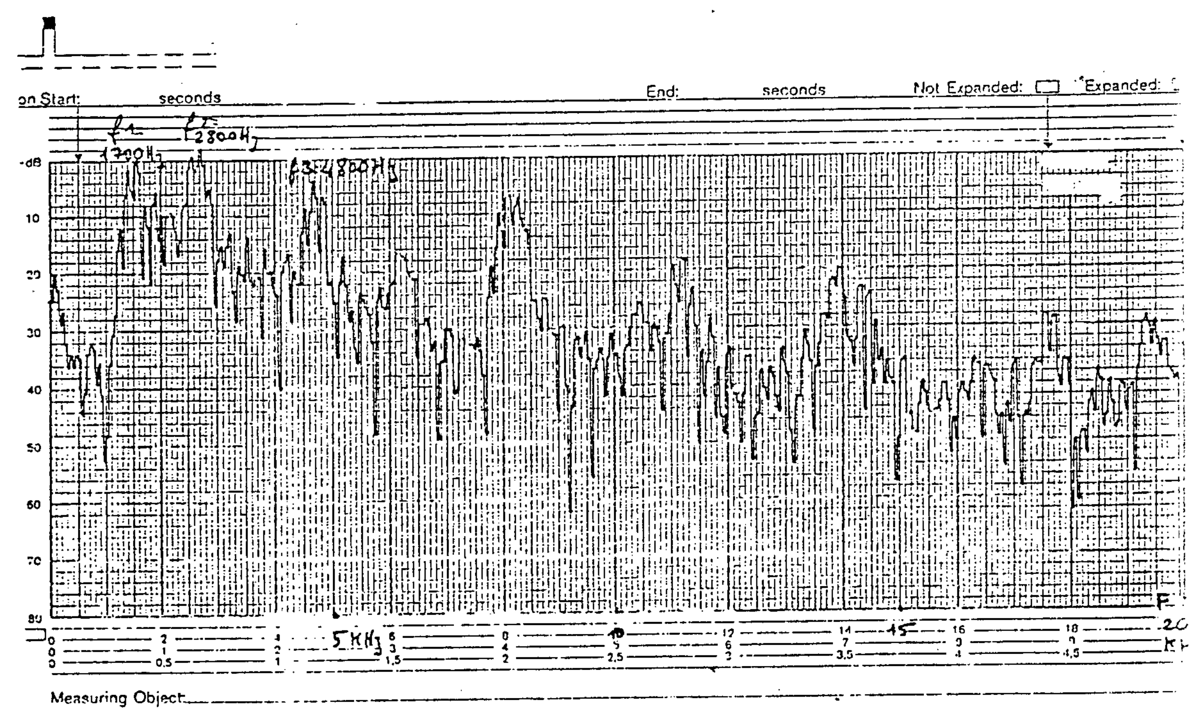


NOISE SCREEN BEHIND A LOUDSPEAKER

Appendix

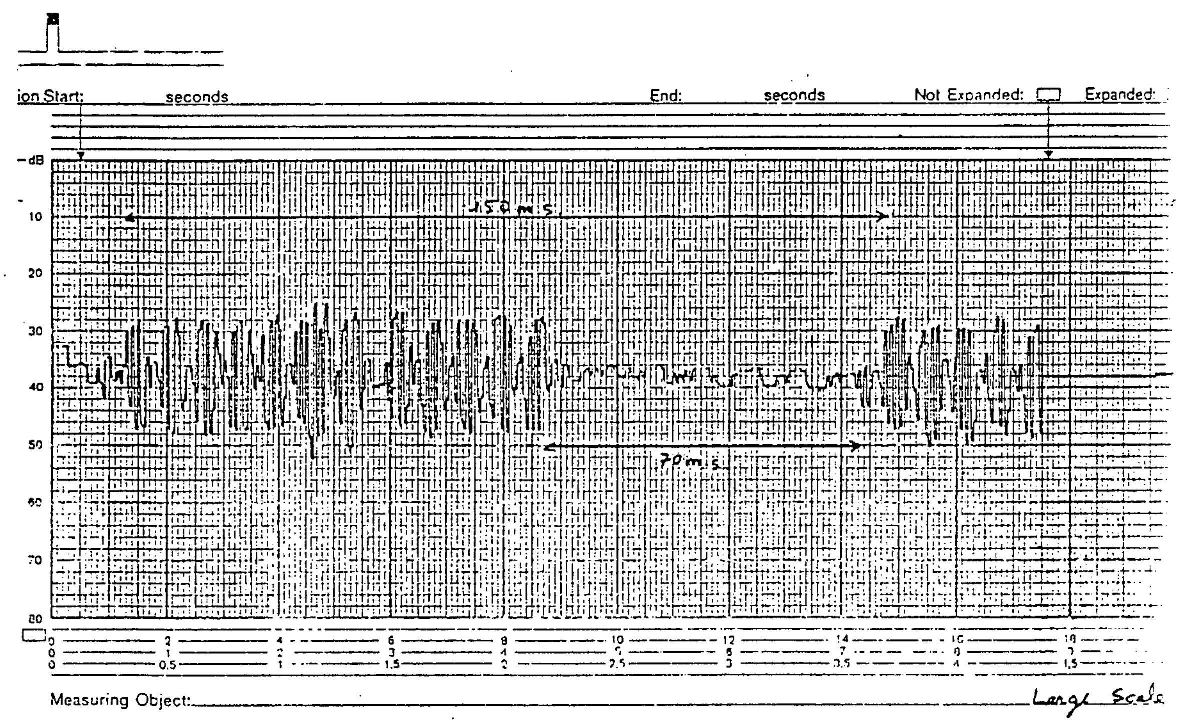
Spectrum of the artificial signal.

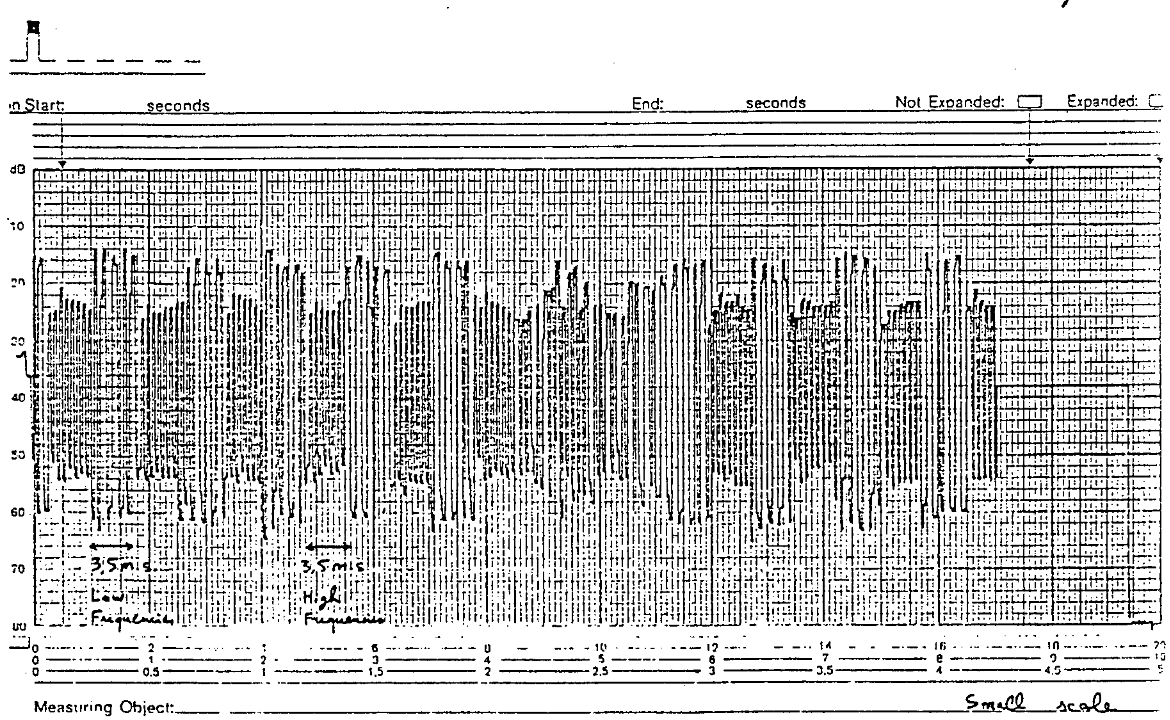




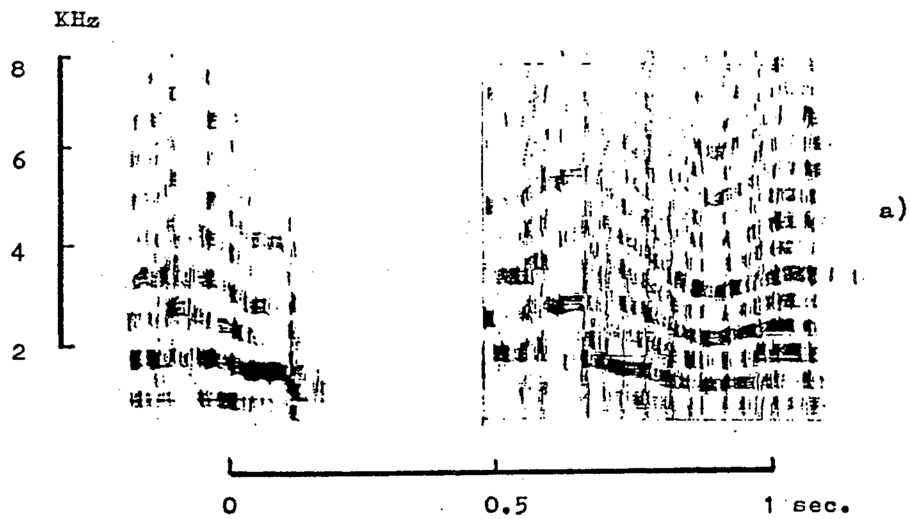
Appendix 1

Temporal evolution of the signal.

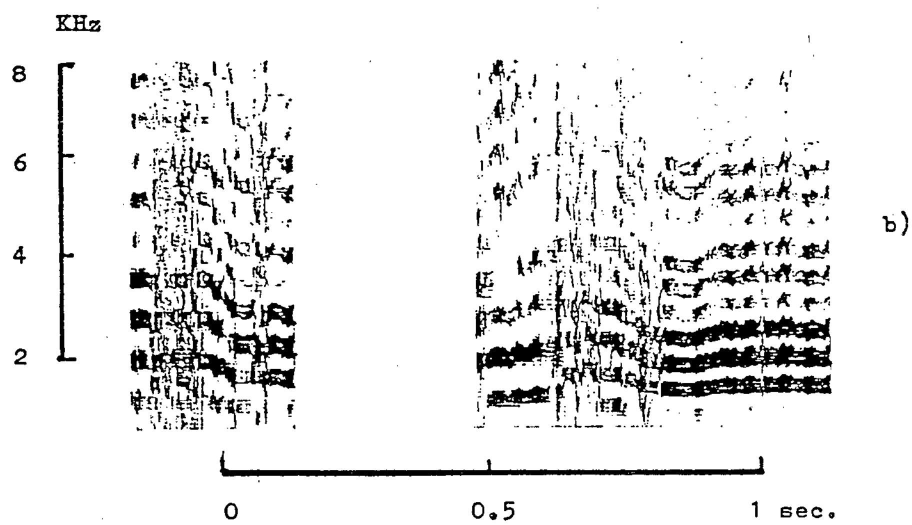




APPENDIX 2



natural



synthesis

Sound spectrogram of a herring gull(Larus argentatus)

APPENDIX 2

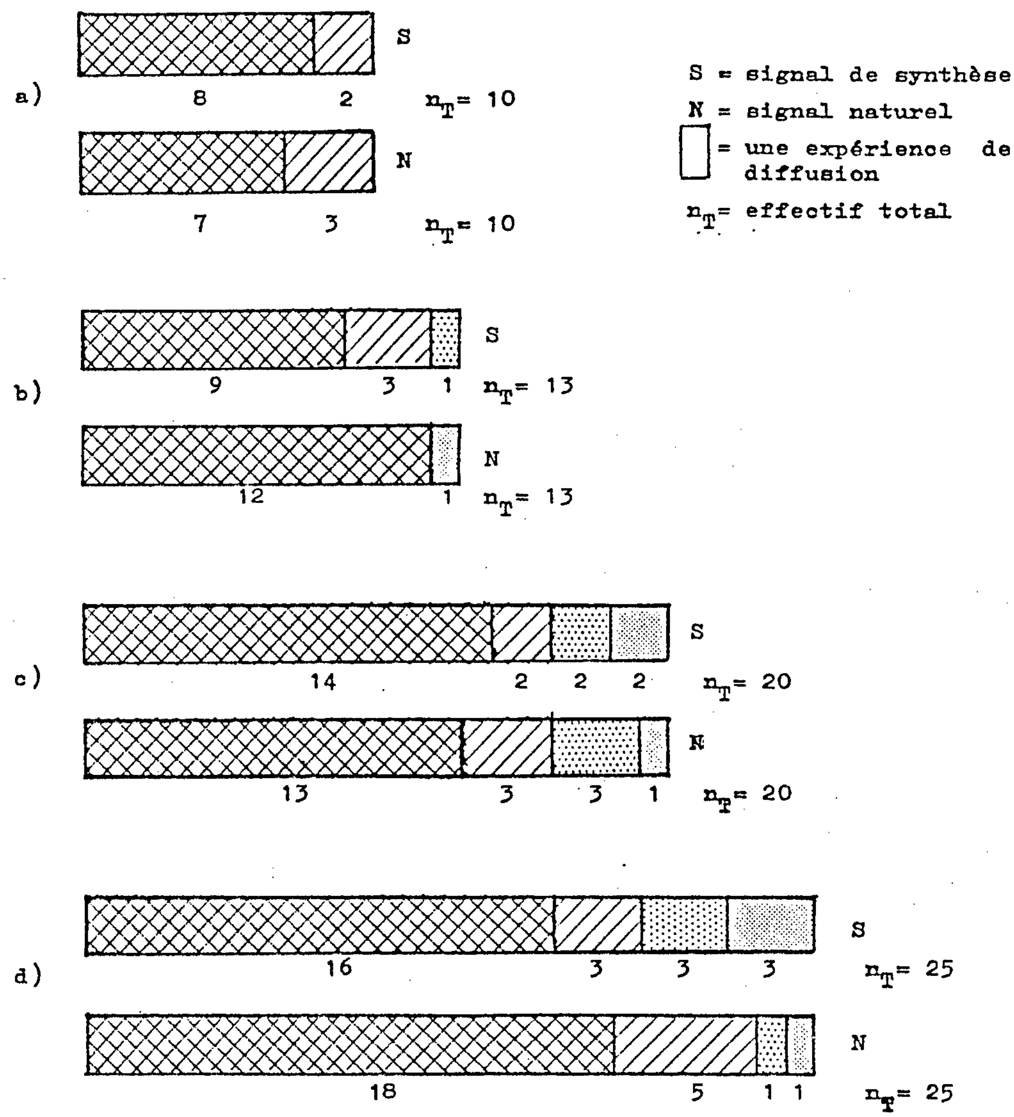


Figure 7: réactions des oiseaux aux signaux de détresse
(synthèse et naturel).
diffusions sur: - a) mouette rieuse
- b) goéland argenté
- c) corbeau freux
- d) étourneau sansonnet

APPENDIX 2

Proportion d'oiseaux réagissant	envol	venue vers la source sonore	dispersion finale après survol	cotation, symbole et dénomination	
tous	immédiat et rapide	rapide	après 2mn	+++	Forte intensité
presque tous	rapide	rapide	entre 1mn30s et 2mn	++	réactions de détresse typiques
la majorité	± rapide	± rapide	avant 1mn30s	+	faible intensité
une minorité	± rapide	± rapide	avant 1mn	+0 +0- +-	réactions mixtes détresse-fuite
tous	oui	non	fuite	-	fuite

Figure 6: résumé des bases de cotation des réactions des oiseaux aux signaux diffusés (d'après BUSNEL & GIBAN, 1965).

APPENDIX 3

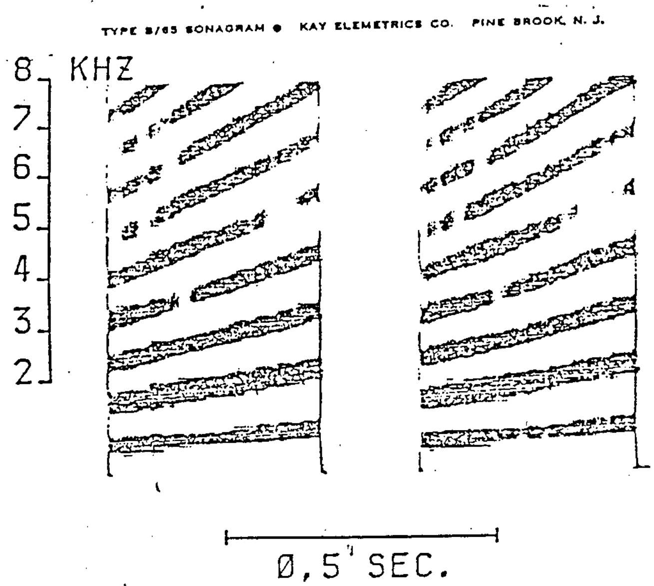
ESPECE TESTEE	SIGNAL TESTE	NBRE DE TESTS	REPONSES NEGATIVES Classes 0 1 nbre (%)	REPONSES POSITIVES Classes 2 3 nbre (%)	RESULTATS STATISTIQUES χ^2_c
Etourneau *Sturnus vulgaris*	Témoin	25	2(8) 1(4) 1(4)	23(92) 5(20) 18(72)	N.S.*
	Interspe 1	20	3(15) 2(10) 1(5)	17(85) 6(30) 11(55)	
Vanneau *Vanellus vanellus*	Témoin	18	1(6) 0(0) 1(6)	17(94) 8(44) 9(50)	N.S.*
	Interspe 1	15	3(20) 0(0) 3(20)	12(80) 7(47) 5(33)	
Corbeau Freux *Corvus Frugilegus*	Témoin	20	4(20) 2(10) 2(10)	16(80) 3(15) 13(65)	N.S.*
	Interspe 1	15	4(27) 0(0) 4(27)	11(73) 4(27) 7(46)	
Mouette Rieuse *Larus ridibundus*	Témoin	13	1(8) 0(0) 1(8)	12(92) 3(23) 9(69)	N.S.*
	Interspe 1	12	4(33) 2(16,5)2(16,5)	8(67) 5(42) 3(25)	

Different birds species reactions to interspecific signal

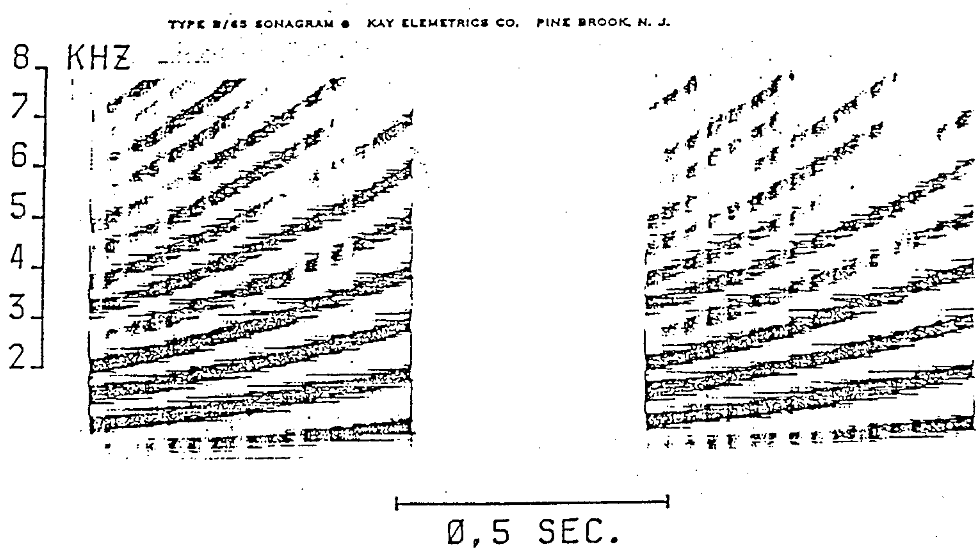
Figure 3: réactions de différentes espèces au signal INTERSPE 1. Pour chaque espèce, les résultats des diffusions de ce signal sont comparés à ceux des diffusions de signaux de synthèse de cris de détresse appartenant à l'espèce testée (témoin).

* N.S. = différence non significative test du χ^2_c avec $p < 0.05$.

APPENDIX 3



a



b

Sound spectogram of two interspecific signals

APPENDIX 4

AV alarm test (1986) — French synthesizer (1987)

LFPO	1984			1985			1986			1987		
Rwy	25	08	?	25	08	?	25	08	?	25	08	?
Birdstrikes on the Rwy	8	12		6	7		2	5		2	9	
Birdstrikes with scarers out of service							5			2		
Birdstrikes over the Rwy or height unknown	5	7	13	8	15	6	9	13	5	11	14	3
Birdstrikes with damages	3	1	3	3	2	0	4 (*)	2			5	
Aborted take off without impact							3			2		

Rwy25:equiped with noise generators

Rwy08:unequiped

(*) 3 during noise generators failures.

falconers (1986) — French synthesizers (1987)

LFPG	1984			1985			1986			1987		
Rwy	28	27	?	28	27	?	28	27	?	28	27	?
Birdstrikes on the Rwy	6	4		6	4		6	9		4	1	
Birdstrikes with scarers out of service												
Birdstrikes over the Rwy or height unknown	14	23	14	19	17	12	8	31	22	10	18	27
Birdstrikes with damages	4	3	2	3	2	3	2	5	5	1	0	3
Aborted take off without impact												

Rwy 27: noise generators,2 loudspeakers on each mast

Rwy 28: noise generators,1 loudspeakers on each mast

APPENDIX 4

noise generators

LFBD	1984			1985			1986			1987		
Rwy	29	23	?	29	23	?	29	23	?	29	23	?
Birdstrikes on the Rwy		4		1	3			5		3	1	
Birdstrikes with scarers out of service											2	
Birdstrikes over the Rwy or height unknown	2	3			5		1	1		5	3	
Birdstrikes with damages	1	1			1			1				
Aborted take off without impact												

Rwy 29: unequiped

Rwy 23: equiped with noise generators

noise generators

LFBT	1984			1985			1986			1987		
Rwy	03			03			03		?	03		
Birdstrikes on the Rwy	8			6			10			15		
Birdstrikes with scarers out of service												
Birdstrikes over the Rwy or height unknown	7			19			11			13		
Birdstrikes with damages	4			3			0			1		
Aborted take off without impact												

BIRD STRIKE NOISE GENERATOR

CSS 87

1. INTRODUCTION

The CSS 87 is a digital noise generator, when used together with our power amplifiers and horn speakers, allows the broadcasting of different signals and bird distress sounds.

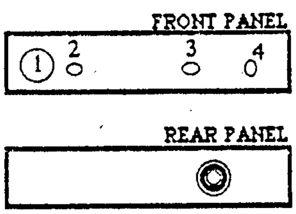
2. DESCRIPTION

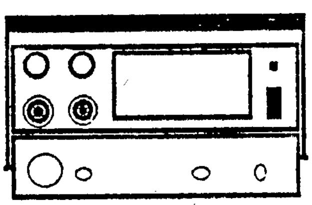
The CSS 87 is available in two types :

a) Portable type : CSS 87 M

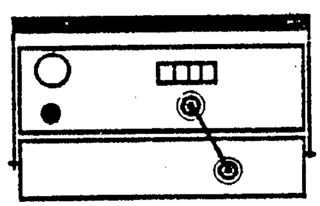
Black painted metal sheet body to be used with our amplifier ref AMD 30B M 30W/12V DC. The two assembled units may be easily installed in a vehicle by means of a U shape bracket.

PACKAGE: CSS87 + AMD30BM + Connection cable + Bracket





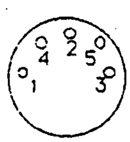
FRONT VIEW



REAR VIEW

1- 11 Positions sound selector switch
2- Reset switch (RAZ)
3- 1 A Fuse
4- ON / OFF Switch

5-Connection receptacle
3 Signal output
4 + 12V DC input
1, 2 Ground
5 Remote control (AMD 30)

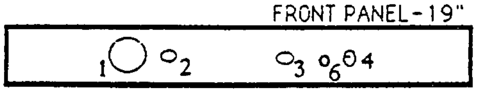


merlaud s.a.
76 Bd VICTOR HUGO 92114 CLICHY - FRANCE
Tel : (1) 47 37 75 14 Tlx : 614 600 F Fax : (1) 47 37 53 10

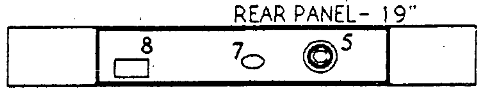
b) Rack mounting type ref CSS 87 R

19"-1U standard black painted metal sheet body designed to be mounted in 19" rack. This model has a 220V/12V DC built-in power supply. Its output signal (-10dB/600Ω) may drive up to about 20 of our amplifiers having their inputs connected in parallel.

FRONT PANEL-19"



REAR PANEL- 19"

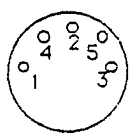


1- 11 Positions sound selector switch
2- Reset switch (RAZ)
3- 1A Fuse
4- ON/OFF Switch

6- "ON" indicator lamp
7- Mains fuse 05 A
8- 220V - AC supply

5- Connection receptacle:

3 Signal output
4 External + 12V DC input
1, 2 Ground
5 Remote control



3. OPERATION

a) Portable type ref CSS 87 M

- Connect the CSS 87 M to AMD 30 B M amplifier using adequate cable cord supplied with equipment
- Connect + 12V DC to AMD 30 B M
- Turn on both units
- Use "RESET" button (RAZ) to start a cycle
- Set "SOUND SELECTOR SWITCH" to requested sound and reset (RAZ button) to start the cycle

b) Rack mounting type ref CSS 87 R

- Connect your CSS 87 R to mains supply
- Connect output signal (N° 5) to power amplifiers inputs
- Turn on (CSS 87 R + amplifiers)
- Use "RESET" button (RAZ) to start a cycle
- Set "SOUND SELECTOR SWITCH" to requested sound and reset (RAZ Button) to start the cycle

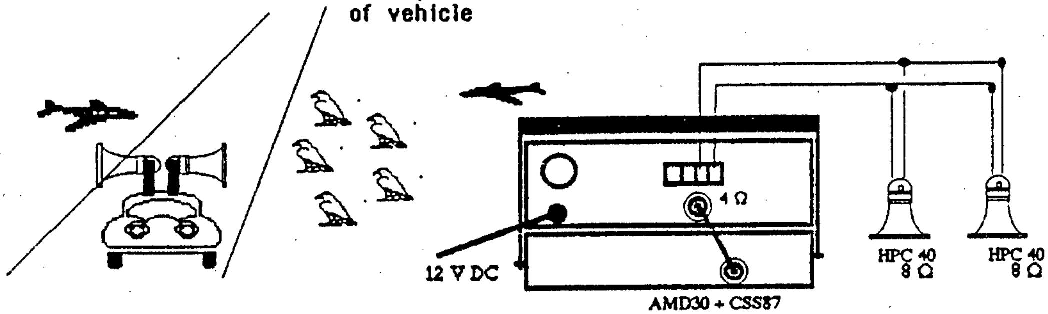
4. AVAILABLE SOUNDS

1- SEA GULL
2- GULL
3- LAPWINGS
4- STARLING
5- INTERSPECIFIC (Mixed sounds)
6- ALARM = : CONTINUOUS ALARM
7- ALARM ~ : ALTERNATIF ALARM
8- HAZARDOUS ALARM
9- SEA GULL + GULL
10- GULL + LAPWINGS
11- GULL + LAPWINGS + STARLING

5. APPLICATION

a) Bird strikes using portable system

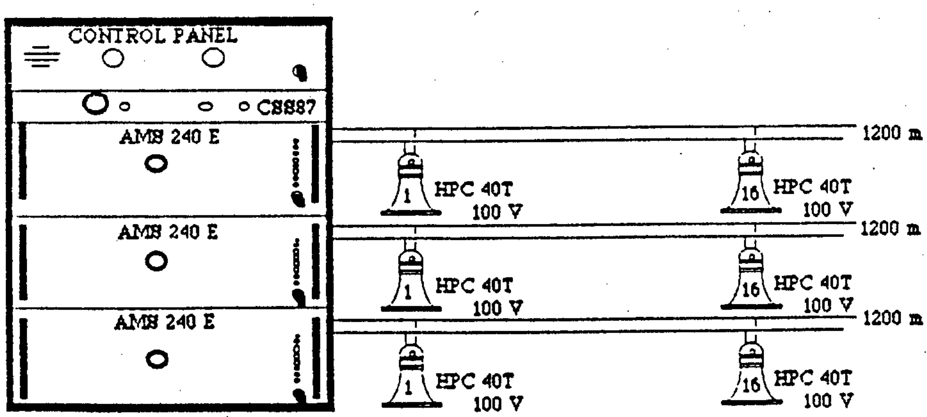
1. Required equipment :
- Noise generator ref CSS 87 M
- 30W/12V DC amplifier ref AMD 30 B M
- Autoreverse cassette player ref TMK
- Horn speaker ref HPC 40 30W/8 Ohms to be mounted on top of vehicle



2. Method
- Draw near birds (100 meters) if possible in wind direction
- Stop your vehicle
- Indentify birds type (ex : Lapwings)
- Turn on the AMD 30 amplifier, the volume control being on position "max"
- Set sound selector switch on requested distress call (ex :Lapwings)
- Should you have any doubt about birds kind, use the interspecific position (N° 5)
- Turn on the CSS 87 M
- Use reset button "RAZ" in order to start the cycle
- Broadcast the sound for about 30 secs max.
- Should the birds fly above the car, fire dual detonation and crackle cartridges with shotguns and special pistols. Use hunting shotguns for species when authorized. If the birds fly in a different way, fire in their direction while emitting the signal.
- In order to avoid habit-forming, try the interspecific signal 1, or replace the digital sound by natural sound prerecorded on cassette to be played by TMK unit.

b) Bird strikes using central system

1. Required equipment :
- Noise generator ref CSS 87 M (rack mounting type)
- N 240 W amplifiers ref AMS 240 E
- N Hors speakers ref HPC 40 T



2. Installation

- Number of requested amplifiers is proportional to runway length
- Two speakers should be fixed on top of 2 meters masts installed every 150 meters at 45 M from runway borders which means 16 speakers and 8 masts for a 1200M runway.
- Amplifiers and noise generator should be installed in a shelter as near as possible from runways.

OPTIONS : Failure detection system

The performance of the whole installation may be electronically supervised to indicate the following :

- Short circuit status (per runway)
- OPEN circuit status (per runway) and/or speakers open coil status (20 % accuracy e.g. 2 speakers out of 16 per runway)
- Amplifiers failure (per amplifier)

Upon detection of any mulfunction or failure the system will report the 3 faults information :

- Near the amplifiers location (one indicator per fault reported)
- To a central monitoring panel via one pair telephone cable using interface circuits allowing up to 32 different indications which means up to 10 runways with 3 faults.
- To a central monitoring panel via one pair telephone cable for each runway without any supplementary equipment but allowing only one indication for the 3 faults (separately or together)

3. Method

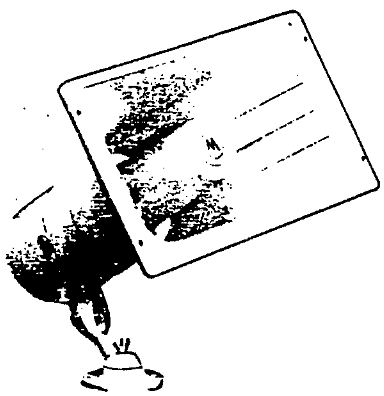
- Set sound selector switch on alternative alarm position (N° 7) in order to broadcast the signal every minute in high birds concentration period at sun rise and sun set.
- HAZARDOUS alarm (N° 8) may be used during low birds concentration periods
- CONTINUOUS alarm (N° 6) is provided to check speakers status and take measurements of sound level on runways by constant signal broadcasting
- SPECIFIC signals (gull, lapwings etc...) or interspecific 1 may be used three to five times a day during low traffic period in order to scare away birds staying behind speakers. Cut the alternative alarm (N° 7), broadcast the requested sound for about 30 seconds then go back to the initial alternative alarm position (N° 7).

6. TECHNICAL SPECIFICATIONS

Output level	-10 dB
DC power supply	12V-1A
Dimensions (WxHxD)	265x45x235 mm
Weight	1 Kg

HAUT PARLEUR A CHAMBRE
DE COMPRESSION
HORN SPEAKER WITH
PRESSURE CHAMBER

Sans transformateur *Without transformer*	HPC 40
Avec transformateur TL 1845 *With transformer TL 1845*	HPC 40 T



- Pavillon rectangulaire en matière plastique moulée
- Socle de fixation orientable
- *Square type loudspeaker plastic moulded body*
- *Revolving mounting base*

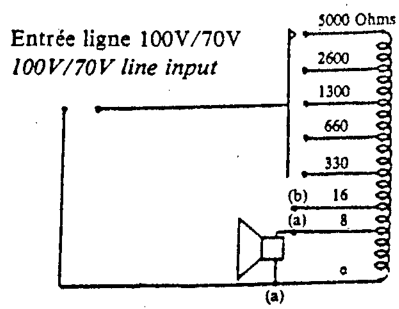
I Spécifications techniques / *Technical specifications*

	HPC 40	HPC 40 T
Puissance nominale *Nominal power*	32 W	32 W
Puissance maximum *Maximum power*	60 W	60 W
Entrées *Input*	8 Ohms	Ligne 100 V *100 V Line*
Pression acoustique *Sound pressure level*	107 dB/W/M	107 DB/W/M
Bande passante *Bandwidth*	450-7000 Hz	450-7000 Hz
Sélecteur de puissance *Power selector switch*	—	5 positions *5 steps*
Dimensions L × H × P *Dimensions W × H × D*	279 × 168 × 285	279 × 168 × 285
Materiaux *Material*	Plastique moulé	*Moulded plastic*
Poids *Weight*	2100 g	2600 g

Bobiné de rechange ref. 4021
Spare coil ref. 4021

merlaud
76, Boulevard Victor Hugo
B.P. 18-92114 CLICHY CEDEX
Tél.: (1) 47.37.75.14 - Telex MERLAUD 614600 F

II Connection / *Wiring*



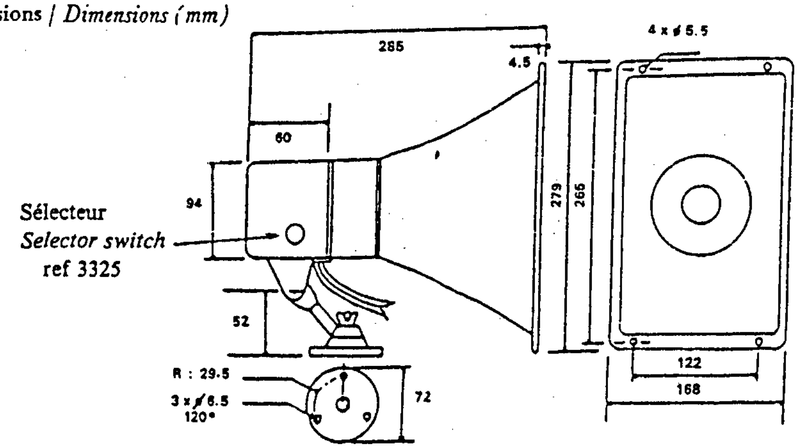
— Livré normalement branché pour ligne 100 V point (a),
— Pour utilisation en ligne 70 V, brancher le haut parleur au point (b).
— Pour utilisation en 8 Ohms, débrancher le transformateur (HPC 40).
— Pour utilisation en 16 Ohms, connecter le Haut parleur au point (a) et brancher l'entrée au point 16 Ohms (b).

— *Supplied for 100 V line operation point (a), in case of 70 line, connect speaker to (b) tap.*
— *For 8 Ohms use, disconnect transformer (HPC 40).*
— *For 16 Ohms use, connect the speaker to (a) tap, and connect input directly to 16 Ohms (b) tap.*

. HPC 40 T : Sélecteur 5 positions ref. 3329 / Transformateur TL 1845
5 Steps selector switch ref. 3329 / Transformer TL 1815

Connexion *Connexion*	Ligne / *Line*			BORNES TRANSFORMATEUR / *TRANSFORMER TAPS*				
				330	660	1300	2600	5000
(a) Normal	100 V	P (Watts) Z (Ohms)		30 330	15 660	7,5 1300	3,8 2600	1,9 5000
	70 V	P (Watts) Z (Ohms)		15 330	7,5 660	3,8 1300	1,9 2600	0,9 5000
(b) Option	70 V	P (Watts) Z (Ohms)		30 165	15 330	7,5 660	3,8 1300	1,9 2600
	100 V	Interdit / *not allowed*						

Dimensions / *Dimensions (mm)*



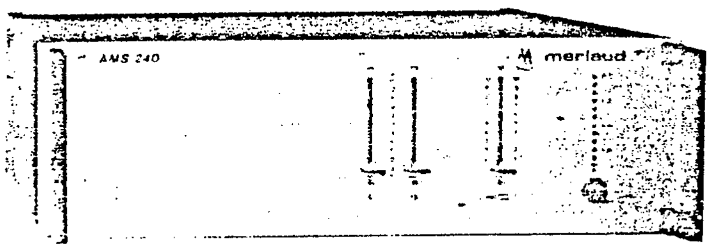
Notice technique n° 2315

AMPLIFICATEURS De PUISSANCE Série E/EC

POWER AMPLIFIERS E/EC Series

- E : sans contrôle de tonalité / without Tone control
- EC : avec contrôle de tonalité / with Tone control

SÉRIE EC

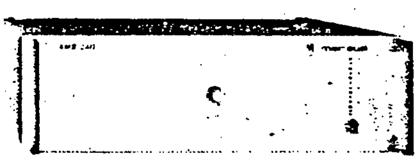


CARACTÉRISTIQUES GÉNÉRALES :

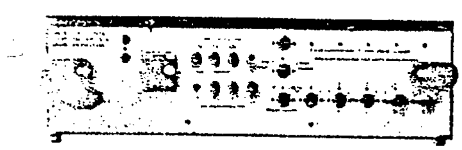
- Echelle de diodes lumineuses.
- Réglage du niveau général par potentiomètre rotatif pour la série E.
- Réglage du niveau général et réglage séparé des graves et des aigus pour serie EC uniquement.
- Prises d'entrées normalisées DIN 5 broches 180° verrouillables (autres sur demande par quantités minima).
- Façade alu anodisé.
- Coffret métallique peint grain cuir noir.
- Standard 19 pouces 3U – Prévoir 2 équerres EQ 8140.
- Protection électronique et thermique contre les surcharges et les courts-circuits.
- Possibilité de l'équiper d'un PES sur demande.
- Disponible en tiroir embrochable 19 pouces avec potentiomètre rotatif à axe fendu (Série E uniquement).

GENERAL SPECIFICATIONS

- Luminous led level indicators.
- Rotary potentiometer general control level for E series.
- Sliding general volume control and separate treble and bass tone control for EC series only.
- 5 Pins 180° Locking Din input sockets others on request per minimum quantities).
- Anodized aluminium front panel.
- Black granulated painted sheet steel body.
- 3 U-19 inch standard rack mouting – add 2 X EQ 8140.
- Overload and short circuit electronic and thermal protection.
- May be equiped with one PES preamplier plug in PC board on request.
- Available in 19 inch plug in drawer type with knobless rotary potentiometer (E series only).



E SERIES
SÉRIE E



Rear Panel
Face arrière

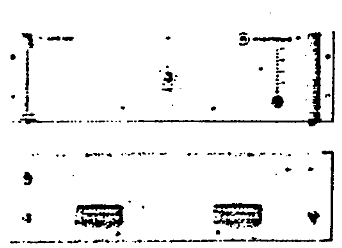
merlaud

Constructions Électro - Acoustiques: 76 Bd Victor Hugo
B.P. 18 - 92114 - CLICHY - CEDEX
Tél: (1) 737.75.14
Télex. MERLAUD 614600F

Spécifications Techniques

Technical specifications

	50 EC	75 EC	120 EC	120 EC /SE	240 EC	50 E	75 E	120 E	120 E /SE	240 E
RMS Power (W) Puissance nominale de sortie (W)	50	75	120	120	240	/50	75	120	120	240
Musical Power (W) Puissance musicale (W)	70	80	145	130	285	70	80	145	130	285
Peak Power (W) Puissance crête (W)	70	105	170	170	335	70	105	170	170	335
Peak to Peak Power (W) Puissance crête à crête (W)	140	210	340	340	670	140	210	340	340	670
Bandwidth Bande passante	40 / 15 000 Hz			40 / 10000 Hz	40 / 15 000 Hz				40 / 10000 Hz	40 / 15000 Hz
Harmonic Distortion Distorsion harmonique	0,5 % / 1 000 Hz			5 % / 1 000 Hz	0,5 % / 1 000 Hz				5 % / 1 000 Hz	0,5% 1 000 Hz
Signal to noise ratio Rapport signal bruit	75 dB	75 dB	75 dB	75 dB	75 dB	75 dB	78 dB	80 dB	80 dB	88 dB
Tone control . Bass Contrôle de tonalité : Graves	± 15 dB / 40 Hz									
Tone control : Treble Contrôle de tonalité : Aigus	± 15 dB / 15 000 Hz .									
Sensitivity Sensibilité	180 mV	180 mV	180 mV	180 mV	250 mV	180 mV	200 mV	250 mV	250 mV	250 mV
Input Impedance : 47 K ohms Impédance d'entrée : 47 K ohms	TE 1243 for balanced input / TE 1243 pour entrée symétrique									
Power supply Alimentation secteur	110/220 V – 50/60 Hz ± 10 %									
Consumption Consommation	100 VA	130 VA	190 VA	190 VA	420 VA	100 VA	130 VA	190 VA	190 VA	420 VA
Battery Power Supply Alimentation batterie				24 V 9 A					24 V 9 A	
Electronic and thermal protection Protection électronique et thermique	Yes Oui	Yes Oui	Yes Oui	therm.	Yes Oui	Yes Oui	Yes Oui	Yes Oui	therm.	Yes Oui
Unbalanced Speaker Outputs Sorties H.P. dissymétriques	4-8-16	4-8-16	4-8-16	4-8	4-8	4-8-16	4-8-16	4-8-16	4-8	4-8
Balanced Speakers Outputs : Volts Sorties H.P. symétriques : Volts	50-70-100 V	50-70-100 V	50-70-100 V	100 V	50-70-100 V	50-70 100 V	50-70-100 V	50-70-100 V	100 V	50-70-100 V
Balanced Speaker Outputs : Ohms Sorties H.P. symétriques : Ohms	50-100-200	33-65-130	20-41-83	83	10-20-40	50-100-200	33-65 130	20-41 83	83	10-20-40
Dimensions (mm) Dimensions (mm)	440 X 132 X 375									
Weight (kg) Poids (kg)	14	16	19	19	22	14	16	19	19	22



19 inch Plug in Drawer type
Tiroir embrochable 19 pouces

— Possibilité d'avoir des puissances supérieures sur une seule ligne 100 V en couplant en série :
AMS 240 E + AMS 240 E = 480 W/100 V

— *Building up to larger power on single 100 V line by series slave amplifiers :*
AMS 240 E + AMS 240 E = 480 W/100 V.

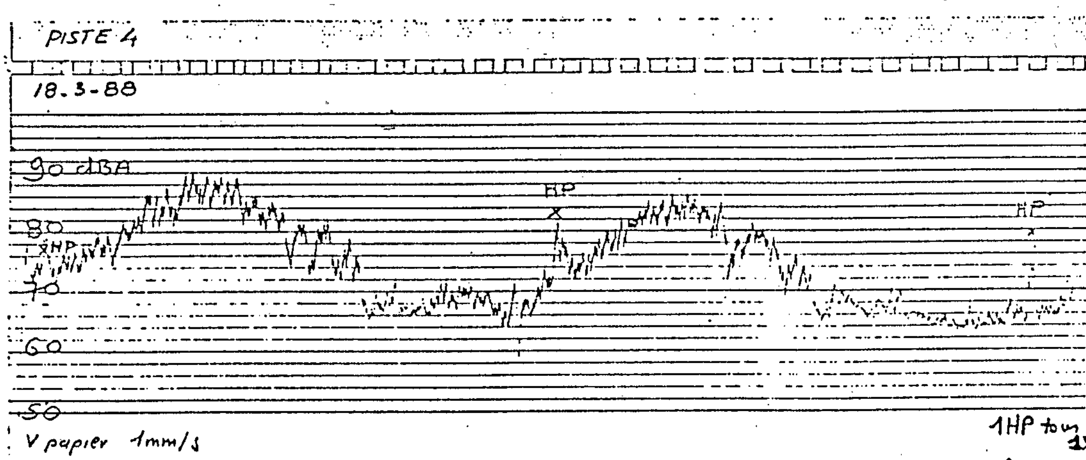
ROPORT DE PARIS

ABORATOIRE

AXE DE PISTE

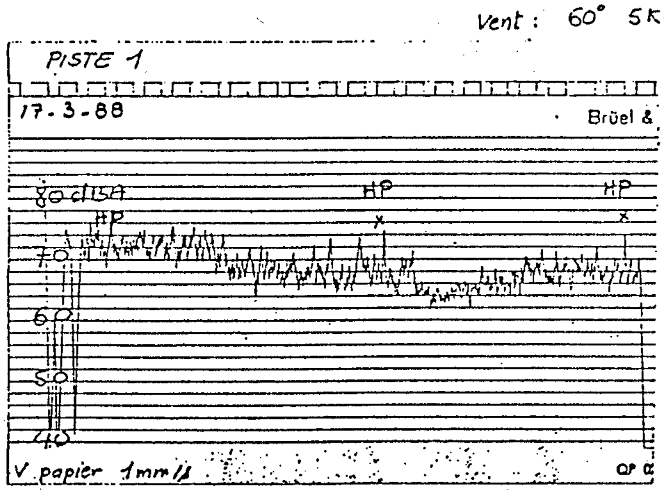
APPENDIX 7

Vent : 80° 4 Kts



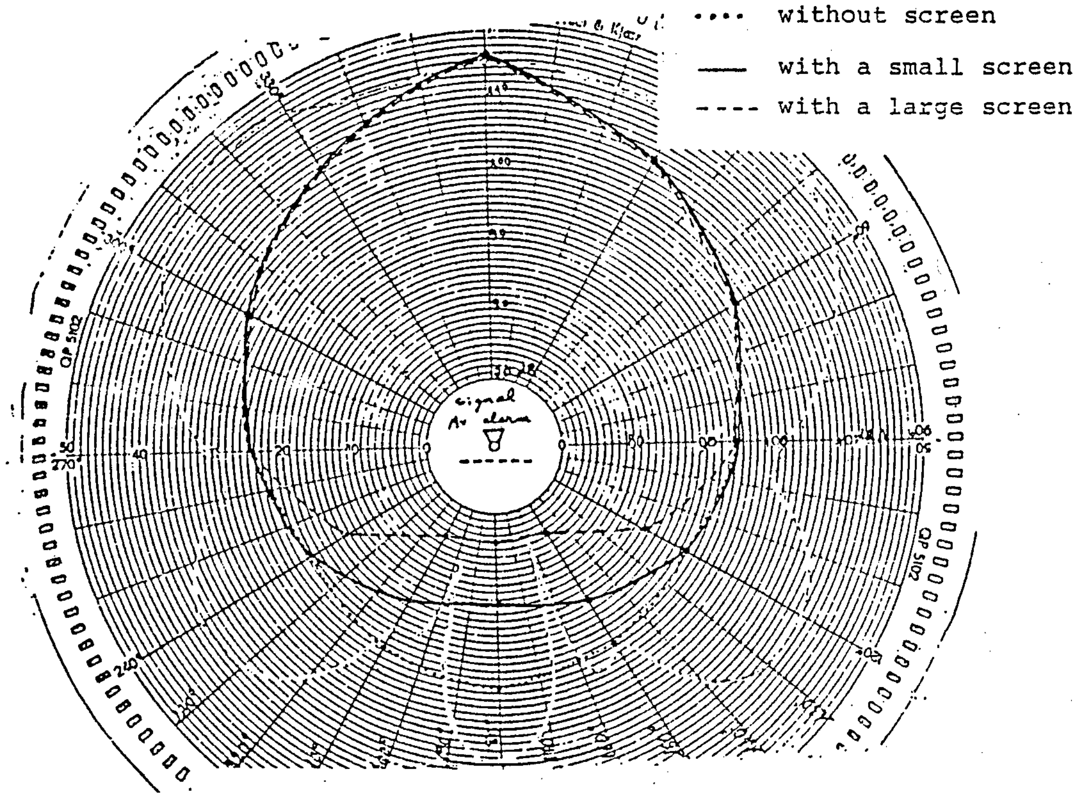
1 HP tous les 150 m
h = 2,5 m

Vent : 60° 5 Kts



1 HP tous les 40 m
à 20 m du bord de piste
h = 0,3 m

APPENDIX 8



HPC 40T MR HPC40T MERLAUD GRADIENT SPEAKER

ADF616030

Engine Bird Strike Tests at Cepr Saclay Test Methods Improvements

(J.P. Devaux, France)

BSCE 19/ WP 32

Madrid, 23-28 May 1988

ENGINE BIRD STRIKE TESTS AT CEPr SACLAY
TESTS METHODS IMPROVEMENTS

by

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DGA/DCAé/CEPr SACLAY
FRANCE

ABSTRACT

The CEPr SACLAY has developed for almost twenty years a full FOD test capacity, in order to offer at the french engine manufacturers a very high level FOD engine test rig, both for development and certification purposes.

Throughout those years, a large number of development tests was performed at CEPr SACLAY TX test rig in order to improve the french regulations and to decrease the costs of full size test on a real engine by testing components under different conditions.

Studies on the tests methods have been achieved to avoid the most severe cases of strikes, considered by the certification authorities as non representative of a real bird strike : those new technologies were applied to the HBPR engine CFM56-5 program.

As the engine and material technology is improving quite rapidly, CEPr SACLAY has to adapt his knowledge to the new engine concepts born a few years ago : in particular, CEPr SACLAY is developing new FOD test technology to face the challenge of firing nine to ten birds into an UHBPR* engine, as the actual regulations ask.

Two FOD campaigns were achieved on composite propellers : the results are very encouraging and CEPr SACLAY will be prepared to test the GE 36 UDF to bird strike hazards.

A video is presented to illustrate typical tests achieved on various kinds of engines.

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* UHBPR engine : Ultra High ByPass Ratio engine

I - GENERAL HISTORY

The CEPr SACLAY (Centre d'Essais des Propulseurs) is the French Ministry of Defence official test center. Although its main activities deal with the flight simulation tests on components and engines for the French Air Force main programs, it is also considered as a technical expert and support for the french civil aviation authority (DGAC). For those reasons, it has been involved very early in birds strike test on engine, both for military and civilian purposes.

The development of the FOD tests technics at CEPr SACLAY are directly related to the the CFM56 program. Before starting the program, french officials services (STPA and DGAC) and french main engine manufacturer SNECMA have launched studies on the bird strike effect on a large fan of an HBPR engine called M 45 : this led the CEPr SACLAY, whose speciality was also the so called "special tests", to develop a test rig capable of achieving those bird ingestion tests, the TX rig (fig 1).

This installation , created in 1975, was completed with a fixed target shoot stand to increase the capacity for development tests on manufacturers products as well as on our bird gun (fig 2).

The installation has performed nearly all the FOD certification tests on the CFM56 engine family (CFM56-2, CFM56-3 and CFM56-5) and was also implied in FOD tests on the Alpha jet engine (LARZAC) and helicopter air intake for AEROSPATIALE (fig 3,4,5).

II - GENERAL DESCRIPTION OF THE COMMON TESTS TECHNICS BEING USED

2-1 Air guns

The FOD test technic consists in firing the foreign objects in an engine at a velocity which is representative of the aircraft velocity during the part of the flight considered by the authorities as the most critical for this kind of hazard.

Most of the tests centers have adopted the air gun technics to launch the projectile at the target. The projectile is put in a carrier which acts as a piston when the compressed air is suddenly released by a "fast opening valve" : the velocity is then a function of both the mass of the carrier plus projectile and the pressure of the compressed air, known by calibration tests.

The differences between the systems built in the world appear when considering the material employed for the carrier, the way the bird is put into the carrier, if the carrier is catched at the end of the tube and the way the "fast opening valve" is obtained. Some differences can also be noticed in the geometry of the guns.

CEPr has chosen for bird strike tests the following philosophy : being capable of firing with the lowest probability of failure and a great repetability one or two birds into an engine, without sending the carrier, which might affect the results of the test. This has led the CEPr engineers to develop a new kind of gun based on the following improvements :

- a "fast opening valve" based on a plastic sheet opened by a detonator

- a projectile carrier catch at the end of the tube, which is capable of retaining through mechanical shock absorbers a mass of 2 Kg launched at a velocity of 400 m/s

- a projectile carrier keeping its integrity during the shock of the catch in order to avoid parts of the carrier to be send in the engine

- a very well known material for the inside wall of the gun in order to improve the repetability of the gun

- a gun recoil absorber in order to improve the impact precision

The more recent air gun type developed by the CEPr SACLAY for the CFM56-5 certification is 5 meters long and has a 140 mm diameter : it can fire a large bird at 400 m/s to covered the military flight at low altitudes domain. Seven to nine of them can be put together on a special support for medium bird ingestion tests on HBPR (1) engine (fig 6).

All the CEPr guns are equiped with a "wire to wire" projectile velocity measurement based on the measurement of the time spend by the projectile between two well known positions inside the gun : the impact velocity is measured with high speed videos or calculated through mathematical models.

(1) HBPR engine : High ByPass Ratio engine

2-2 The sequence

The CEPr philosophy implies the use of a special automatic system capable of managing the whole firing sequence that is :

- the high speed cameras needed for the understanding of the test, and therefore the intensity of light put on the target

- the different electrical sources needed to feed the detonators

- the meteorological or engine parameters analysis

- etc...

As the good working of all servitudes put around the engine to measure or to analyze after the shot its behaviour is considered to be the most important thing to ensure before the test starts, the sequence automaton is also equiped with all the alarms needed to stop the firing sequence when things go wrong. Those alarms concern the behaviour of the engine before the test as well.

III - MULTIPLE STRIKES PROBLEM

CEPr tests engineers call multiple bird strikes the case of two or more birds impacting the same fan blade at quite the same height. During certification tests, the case seems to be more common than predictable as most of the engine manufacturers have faced the case of three birds impacting the same blade at the same height, with most of the time very bad results obtained due to the relative weakness of a blade which has been two times severely impacted.

CEPr SACLAY also had to face such a problem and has recently tried to find appropriate answers in order to avoid the case of three or more impacts on the same blade, as it is not considered as representative by the civil aviation authorities (2).

3-1 Studies

Two kind of studies have been launched by CEPr to understand the way such multiple impact could happen and try to estimate the risks for new certification tests.

(2) To our best knowledge, no case of medium size bird multiple impact on engine in service were noticed during the last ten years.

It was first necessary to understand how the performances of the firing system, sequence automaton included, could affect the arrivals of the birds on the fan. This has been done by analysing both the CFM56-2 and CFM56-3 bird certification tests and by analysing the performances of the former installation in order to have good mean characteristics of it. We noticed that whatever the firing sequence will be, a deceleration of the fan velocity occured approximatly when the first three bird strike hapenned (fig 7) ; then the mean deceleration rate is quite constant during the other strikes. Most of the time, when the test was successful, the deceleration ended before the last strike.

A current deceleration rate was included between 1500 and 3000 rpm/s/s, so that for an engine running at 4500 rpm, the difference between the estimated location of the impact through a simple calculation and the real location could easily be measurable in rounds : this led the CEPr to consider that the only way to avoid multiple bird strike was obviously to connect the automatic firing system to a fan velocity measurement and try to integrate this measure into the sequence, although it complicates the automaton quite a lot.

A second fact appears quite rapidly in our studies : the way of firing the birds was as so important as the knowledge of the most probable location of the impact. CEPr has never adhered to the philosophy consisting in firing all its birds at the same time (although its installation authorizes such a shot) considering that it is not representative of what can happen on an air field. CEPr engineers have tried to determine the real concentration of both little birds and medium birds when high concentration occurs : from there it was possible to estimate a majoration of it and translate that to the case of a test.

The results obtained shown that when all the birds were fired at the same time, the decelaration rate was more important and more hazardous than in the case when the birds were shot one after the other : this can be explained by a "recovery factor" of an impacted blade, which when hurt, bent and draw from itself up under the action of the centrifugal forces. If the blade is hurt, even by a very little part of a bird during this action, the dammages are often more severe and the abration more important.

All of this led the CEPr to choose a firing sequence which minimizes the risk of multiple strike by controling the way of arrival of the bird, within the regulation recommendations.(3)

(3) The FAR and JAR requirements authorize a one second firing sequence.

A mathematical simulation was developed to analyze the different possible behaviours of a sequence. The parameters considered were :

- the projectile repartition
- the firing sequence : this include the possibility of tie down the fire to the velocity of the fan
- the decelaration rate of the engine and the time when it occurs
- the parameters describing the repetability and the precision of the projectiles, of the guns and of the sequence automaton : all those parameters were calculated or estimated through calibration tests performed on all the implied elements of the installation

3-2 Applications

All the results obtained with the different studies show that the reliability and precision parameters were also very important : in fact they were the only non hazardous parameters on which important improvement could be made and tested before a big FOD campaign.

Conscious quite rapidly of this fact the CEPr has developed its new bird artillery with the purposes of minimizing the uncertainty on the following parameters :

- projectile velocity
- time spent between the authorization of fire and the strike
- localisation of the strike (3)

The uncertainty envelope was given by the models and checked by calibration which was the only way to show where an effort should be made to improve the system.

The results obtained were very satisfactory with a bird strike precision estimated +/- 30 degree on a rotating fan (4900 rpm). This technology was applied to the CFM56-5A program with a big success (fig 8).

(4) This test is realized without the engine running and therefore does not take in account the aerodynamical effects of the air intake on the bird.

IV - PROJECTILE CHOICE

One of the most exciting discussion most of the bird strike test engineers may have, consists in comparing the advantages and the disadvantages of all kind of birds they have to fire into an engine. CEPr is not an exception and this has been one of the most important activities of the bird strike team.

The CEPr unique bird was the common chicken : the reasons put forward by the center when someone asked why, were mostly political reasons :

- most of the birds concerned by the bird strike were protected in France, and therefore not available for test purposes.

- it was really difficult to find a dozain of real birds having the good weight when the poorest calibration campaign need quite a hundred of birds to be fired.

- even if it is authorized, finding and killing real birds without guns is quite impossible to do.

CEPr state of mind has changed after the discussions it had during the CFM56-3 bird tests with GENERAL ELECTRIC and SNECMA. The experience of GENERAL ELECTRIC shows that the chicken was not as so good as it seems for different technical reasons related to the fact that it is not a real bird as it not flies. In addition to that, the CEPr chickens were farm chickens raised to produce meat. All those elements led to have a bird projectile density too far from the reality.

Comparative tests were programed then to compare the damages done by different kind of birds : seagull and chicken were tested at SNECMA and at CEPr, as CEPr has the ability of using wild seagulls living in the south of FRANCE and provided by the DGAC. Both static and dynamical tests were performed : the results were very different, but the analysis of them lead to the conclusion that the seagull was a more representative bird for engine tests, when comparing them to the in flight bird strike data base.

The SNECMA tests were done on a whole rotating fan : a semi-dozain of birds were shot on the tip of the fan blades and compared to the dammages caused by chicken. The ladles obtained were less important when considering a single blade, but more in terms of number of blades hurt.

The CEPr tests were achieved on static blades grid under axial load : the dammages encountered when firing a seagull were more important as one blade supported the whole bird in this case and not when using chicken (fig 9). The CEPr tests have also proved that the seagull was a better projectile in term of strike precision, due to its flying capacity and morphology.

All those elements have decided the center to use natural seagulls for official tests as the most representative birds, even it is quite difficult to find a 1.5 lbs or a 4 lbs bird in a species where the average weight is 2 lbs.

Analysis are still continuing to analyze now how the way the birds are freezed or shot might influence the results of the tests. In particular, the influence of the gun diameter on the effects of a strike has to be studied a little bit more.

V - TESTS TECHNICS ENHANCEMENTS FOR PROPELLER BIRD INGESTION CERTIFICATION

The more recent developments in propulsion technology are for the five years to come a source of new development tests as there is no real regulation which can be exactly apply to the new UHBPR (5) engines: neither a turboprop engine, nor a turboreactor, the propfan is the next challenge to face for the bird tests certification.

For now two years, the CEPr is preparing all its installation to this new kind of problems. Two bird strike campaigns have now been realized first to check the effect of bird impact on rotational propeller blade in comparison with static test results and secondly to determine the nature of the problem to be solved when CEPr will have to test an UHBPR engine.

5-1 Analysis of the campaigns

The first campaign occured two years ago and the main aim of the tests was to analyze the behaviour of a composite propeller blade during a bird strike : the propeller was a three blades BASTAN propeller from RATIER. At first, static tests on a composite and a metallic blade were performed, then two propellers, one in composite material, the other in type design material were tested on the rotational test rig, without a turboshaft (fig 10).

The test installation was not precise enough to allow an axial shot on a blade, so that a new shot technic has to be found : the gun was put in the propeller plane and the propeller pitch was adjusted to zero. A dozain of shots were achieved without major troubles. However , this first test has shown that a new concept was now necessary to face the challenge.

The studies led from these results were concluded by the introduction of a "blade aimer" and an angle calculation module using the propeller velocity in the automaton : a first demonstrator of this technic has been built and tested for the qualification of the TRANSALL composite propeller to foreign object dammages. The propeller was propelled this time by a TYNE turboshaft engine in order to check the whole propulsion system (fig 11).

This new campaign of FOD tests performed on a four blade propeller is currently achieved at CEPr TRANSALL propeller test facility HO rig : the FOD installation allows now an axial shot on a designated blade(6). The automaton and the gun being used were precise enough now to touch a rotating blade with a little stone of 30 gr.

This encouraging result shows the CEPr that the choosen concept seems to be the good one. Many studies should now be done to improve the reliability and the precision of this new system.

5-2 Application to the UHBPR engine testing

With the UDF GE 36 program, SNECMA and GE have launched now a new step in the propulsion evolution : this engine must be certified and there is no doubt that it will be necessary to check the compliance of this engine with the bird strike regulations although there is no one existing at the present time for this kind of engine.

Although it is not presently concerned by development or certification tests, CEPr SACLAY is presently studying the way FOD tests could be achieved on contrarotative propellers of an UDF engine, the main axis of thinking being the shots on the second propeller without hurting the first one and the aerodynamical effects around the nacelle.

Though there is no data base available to work, CEPr is also trying to analyze the problem of the multiple strikes during a medium bird ingestion test on an UHBPR engine to avoid such a problem if it has to achieve such a test in the future. But, if some ideas can be extended from the HBPR engine testing without problem, other like the decelaration rate cannot be really analized without development test.

(6) both in terms of engine set up and bird velocity.

VI - CONCLUSION

The recent successes of the CEPr SACLAY in FOD testing are the direct consequences of four years of research on the test installation itself and the causes of the multiple strikes. It lead us to understand the necessity of developing high level technology for these kind of tests to get a high reliability in order to be more confident in the installation which must not be a source of problem when realizing such tests.

All the improvements presented above are not commonly used at the present time, but most of them will be employed in the next five years for the certification or the qualification of the french manufacturers propulsors.

Like the other centres we are facing the future to keep what we consider to be one of our major successfull activities during the past ten years and to participate to the challenge of the new regulation writing and testing for the UHBPR engines.

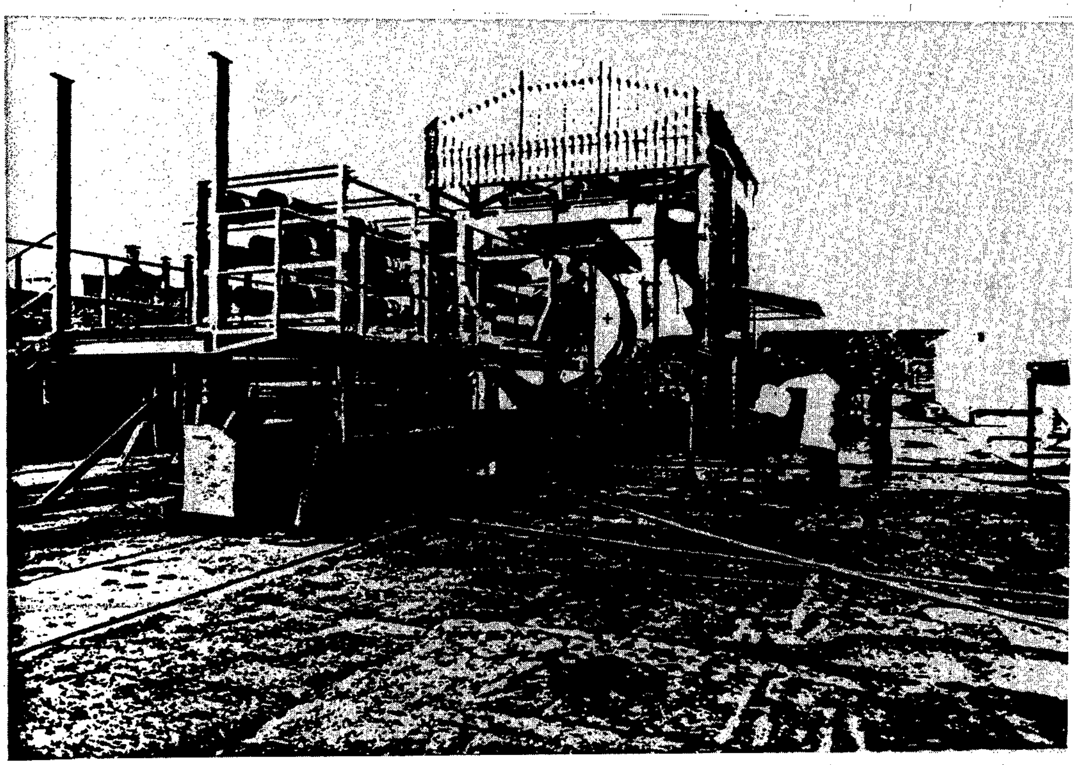

Figure 1

TX rig engine test facilities
(Photo CEPr 87 280)

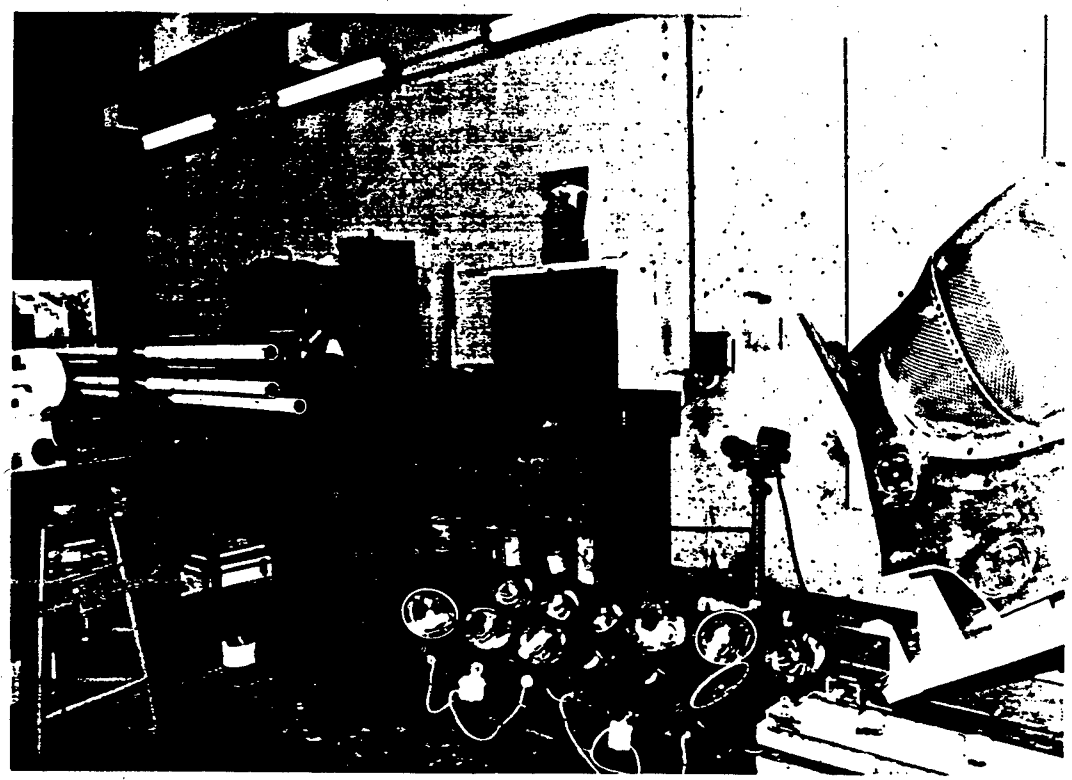

Figure 2

TX rig fixed target test facilities
(Photo CEPr 87 2143)

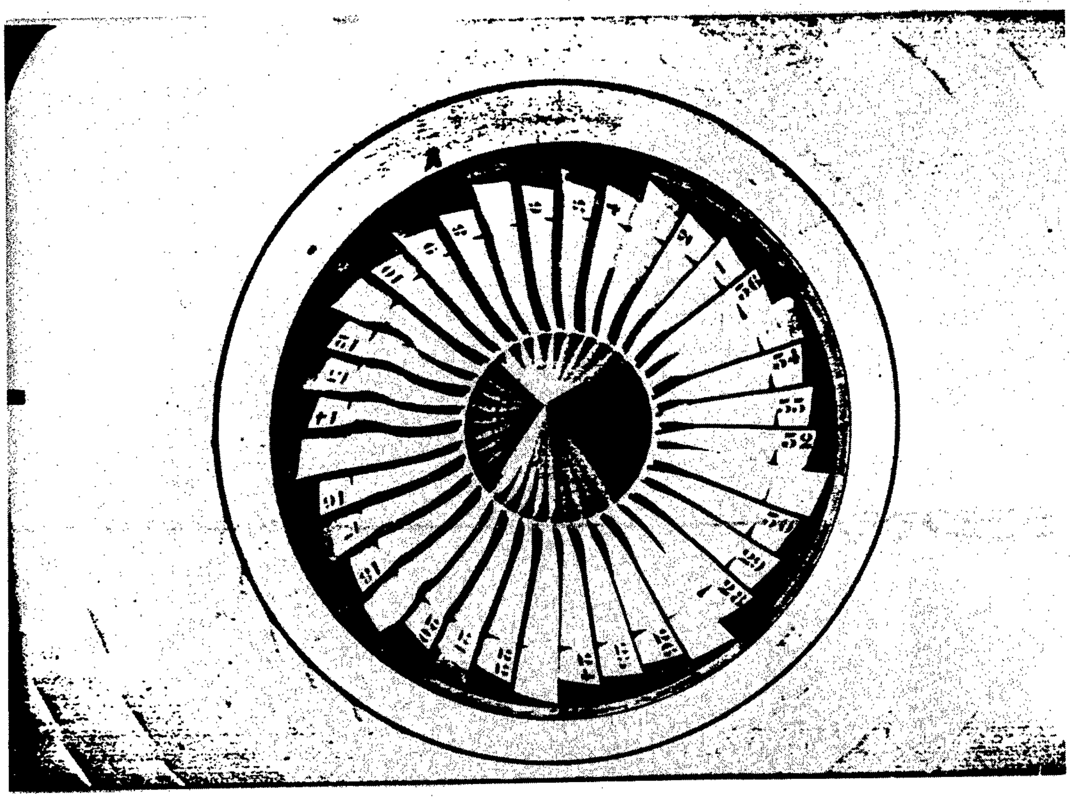

Figure 3

Medium bird certification test on the CFM56-5A1
Dammages encountered
(Photo CEPr 87 1061)

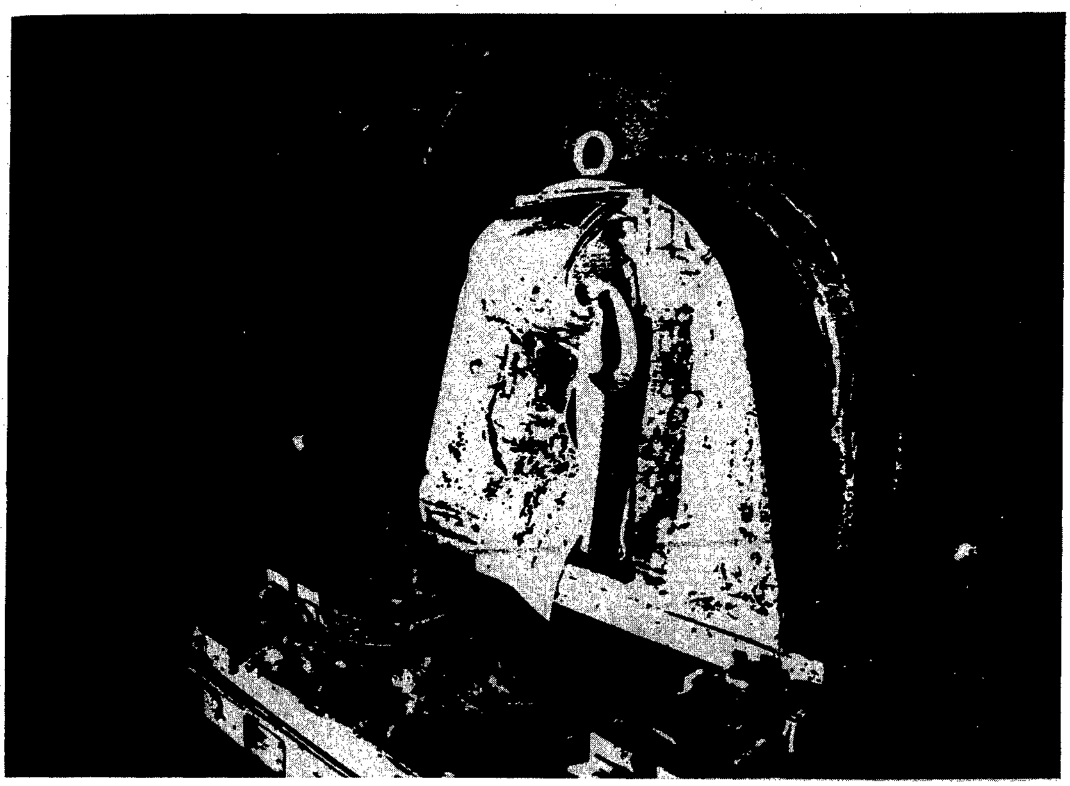

Figure 4

Medium bird qualification test on an airborne equipment
(Photo CEPr 87 1460)

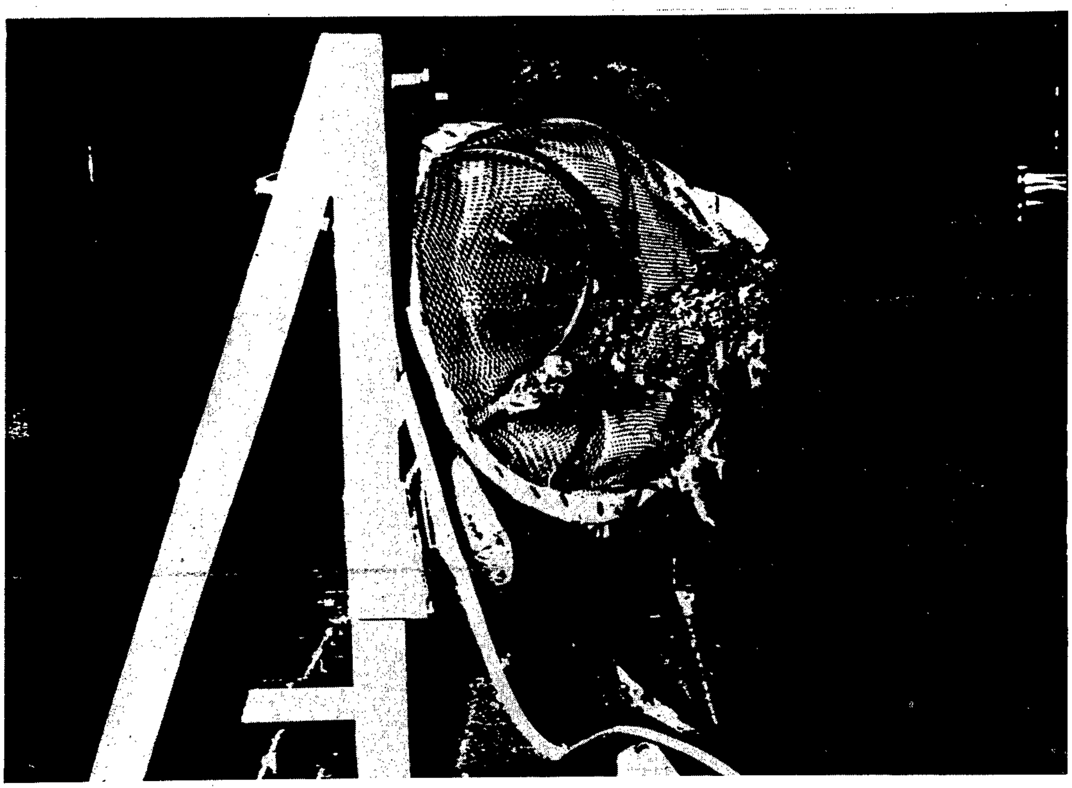

Figure 5

Heavy bird certification test on an helicopter air intake
(Photo CEPr 87 5658)

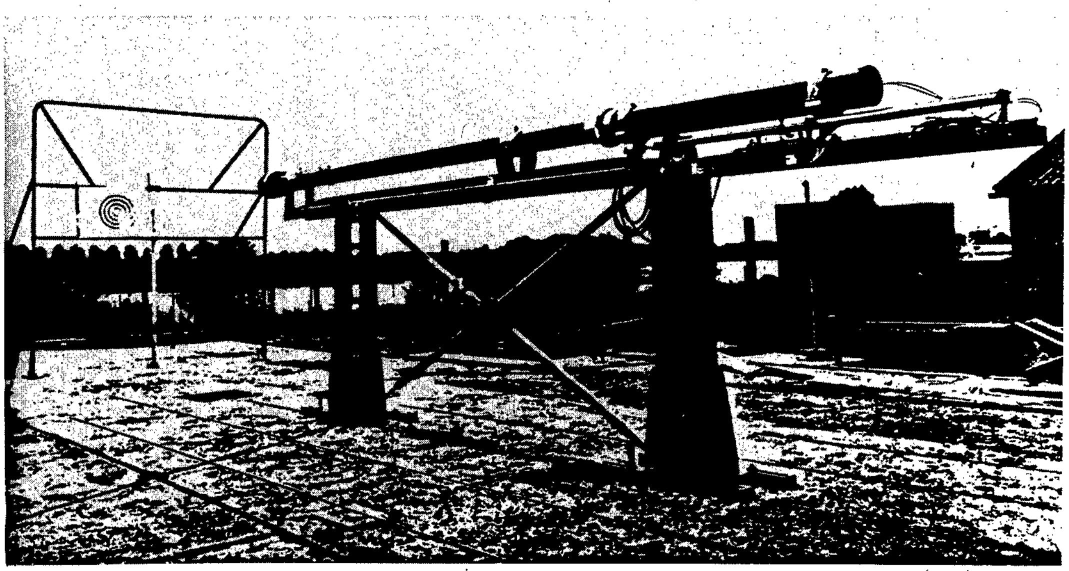

Figure 6

Typical CEPr air gun
(Photo CEPr 87 3485)

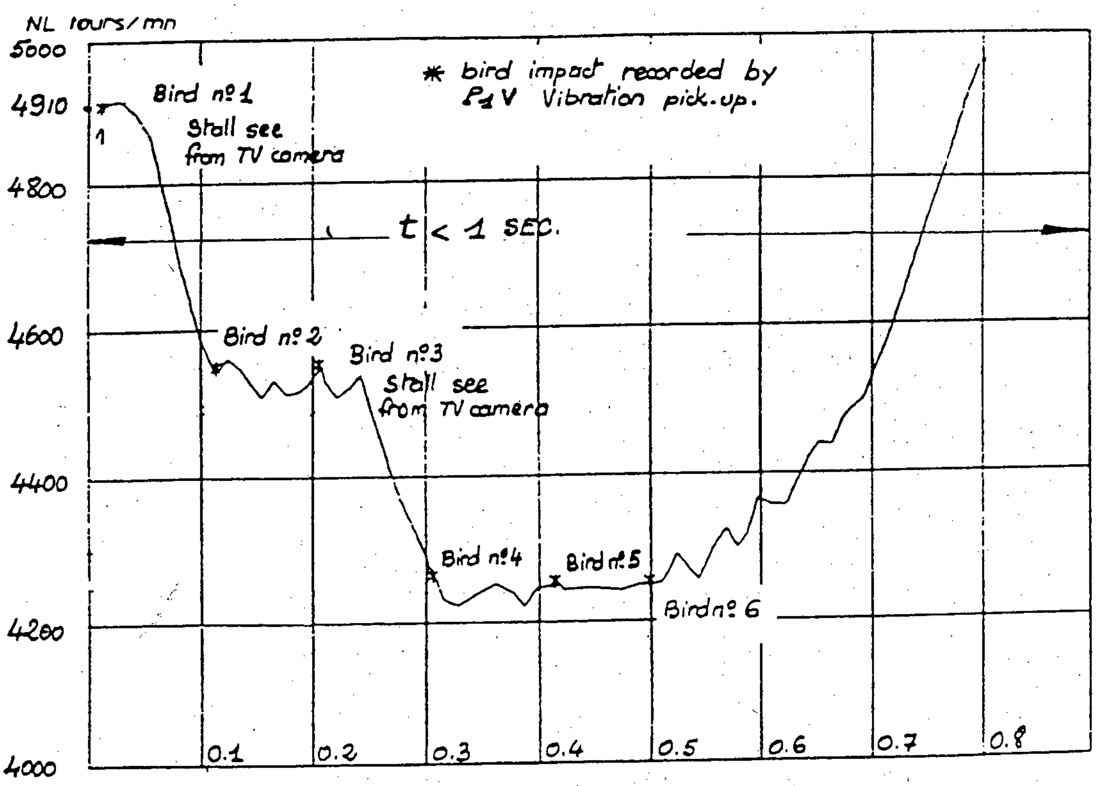

Figure 7

Fan speed during a medium bird test

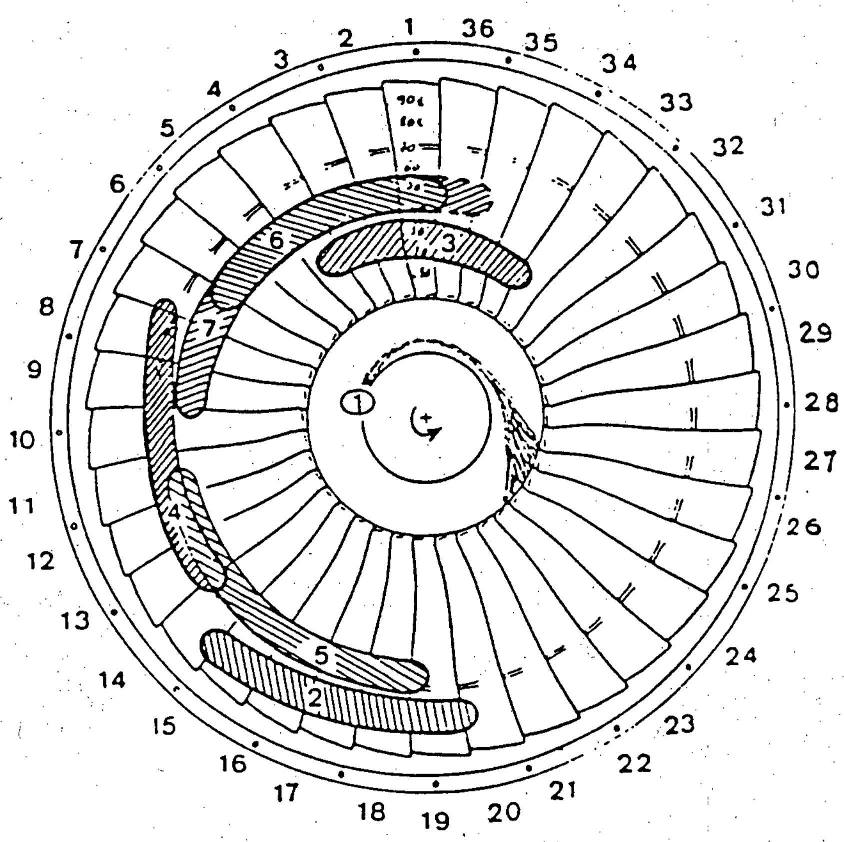

Figure 8

Medium bird certification test on the CFM56-5A1
Impacts location on the fan

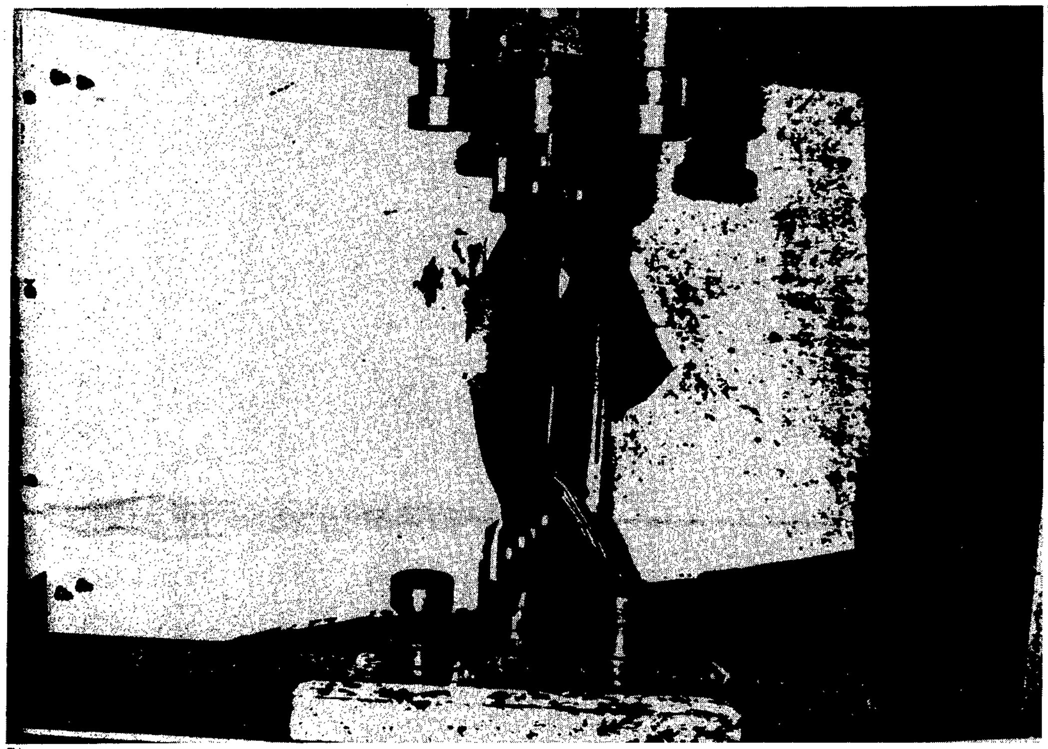

Figure 9

Static blades under load installation
Dammages encountered
(Photo CEPr 86 ...)

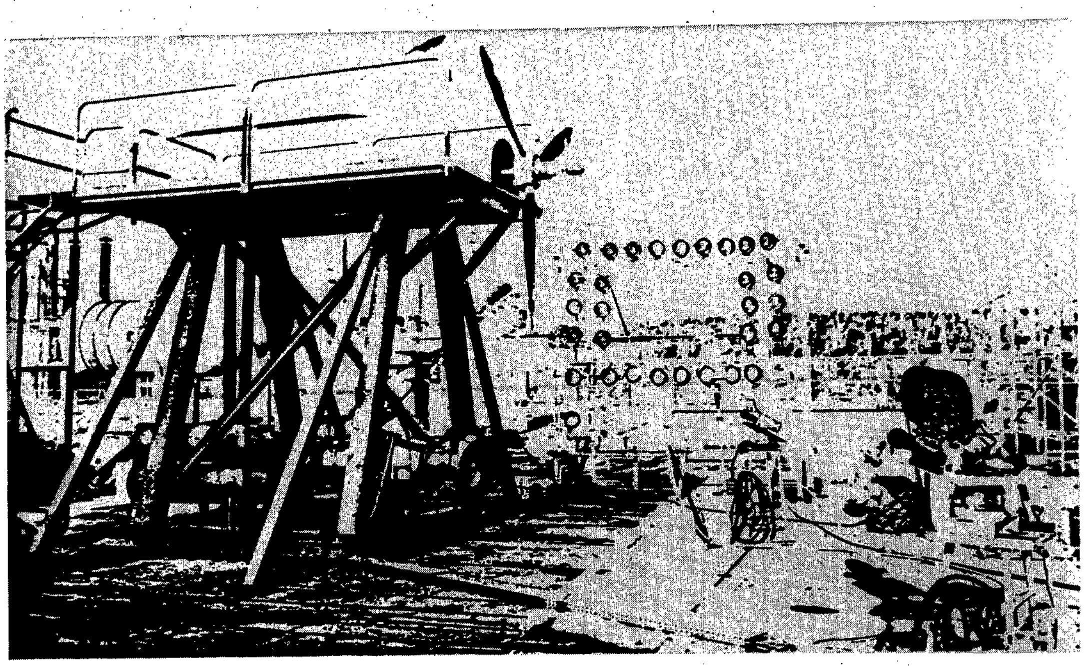

Figure 10

TX rig Propeller test installation
BASTAN Propeller campaign
(Photo CEPr 85 211)

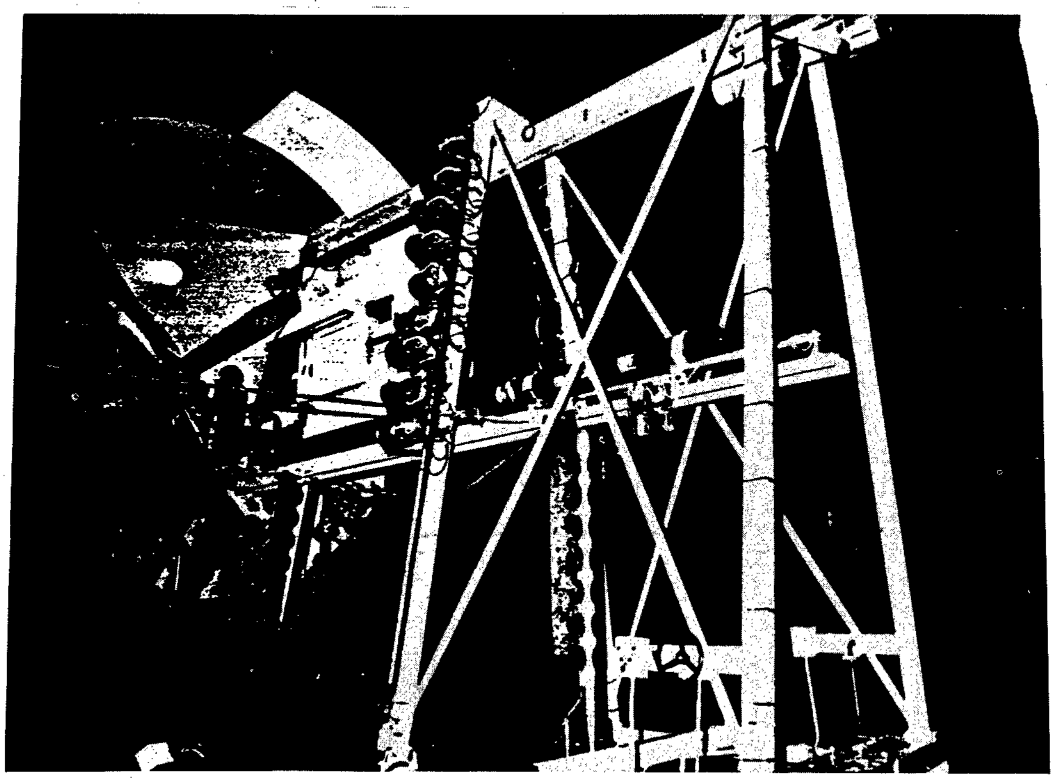

Figure 11

H0 rig Propeller test installation
TRANSALL Propeller qualification campaign
(Photo CEPr 88 5566)

ADF616031

How Meanigful are bird strike statistics

(Callum Thomas, England)

BSCE 19 / WP 34

Madrid, 23-28 May 1988

HOW MEANINGFUL ARE BIRD STRIKE STATISTICS

Dr. Callum Thomas, Bird Control Officer, Manchester Airport, England

SUMMARY

Data are being collected throughout the world about bird strike incidents and many countries have established systems for collating and analysing this information. The limiting factors in these systems are the level and quality of reporting by people on the airfield and on the flight deck. A number of sources of weakness have been identified and appear to require a comprehensive education campaign. The analysis of, and interpretation of bird strikes statistics and in particular the way in which they are published can lead to misinterpretation by airport management, who may look for a simple numerical representation of their own hazard while not appreciating the statistical and biological limitations of such data.

1. *INTRODUCTION*

Bird Strike reporting systems have been in operation in many countries for a number of years and it is generally accepted that the statistics arising from these reports provide a valuable insight into the aviation bird hazard. However, standards of reporting vary enormously and bird strikes are comparatively rare events with the result that the data set available for statistical analysis is reasonably small. Much of the published data relate to compilations of information from a number of airports, and these can give a deceptive impression of the bird strike hazard at each and yet airport managers who are responsible for airfield safety may make operational decisions based upon these statistics without an adequate knowledge of the relevance of them to the bird hazard at their own airport.

Although there are common features to the bird hazard at different airports, each is individual in nature and while bird strike statistics can be a useful adjunct to field data collected on the behaviour and ecology of birds at a particular airport, they are too often viewed in isolation.

This paper reviews the various week points in bird strike reporting systems, the statistical analysis of bird strike reports and the presentation of those data. It aims to stimulate discussion about the way in which this valuable source of information should be collected and handled in the future.

2. *STATISTICAL NOTE*

The data presented below come primarily from Manchester Airport and much of the discussion is concerned with strikes which occur on the Airport, rather than en route. The sample size of the data set is small and in some cases, multivariate analysis is not possible. The data are, therefore, statistically weak. However, in order to illustrate various points, these weaknesses have been ignored.

3. *BIRD STRIKE REPORTING*

3.1 *Where do bird strikes originate from?*

Bird strike reports arise from one of three sources:

1. *from pilots of aircraft which have experienced a strike.*
2. *from groundstaff who find a corpse on the manoeuvring area.*
3. *from engineers who find evidence of a bird strike during a routine inspection of an aircraft.*

Bird strikes may be reported directly to the national or international bird strike coordinating organisation, or indirectly through the air traffic control service at an airport.

3.2 *The level of reporting*

The standard of reporting of bird strikes and the quality of the bird strike reporting system varies enormously from country to country. But even within a single country the standard is better at some airports than at others. Variation in reporting standard can occur at a single airport under the same conditions with different reporters.

The probability of a bird strike being reported and the accuracy of any report is dependent upon the phase of flight when the strike occurs, how busy the air crew is and how busy the air traffic controllers are. This immediately leads to under reporting. Since the extent and nature of the bird hazard at an airport varies through the day and year, as does the number of aircraft movements, this can also lead to a sampling bias in the data.

Ground staff at many airports are not aware of the need for reporting dead birds found on the airfield and may be unwilling to trouble busy controllers for details of aircraft movements. In addition, they can face a conflict of interests. A high level of reporting by ground staff results in an increase in the number of strikes reported by a particular airport. An uninformed management may interpret this as a failure on the part of the bird control staff and this pressue can often lead to a decline in the reporting of corpses discovered on the runway in the absence of a pilot generated bird strike report.

The quality of reporting by groundstaff alone can give rise to a 40% reduction in the number of strikes reported from an airport. Before the employment of dedicated bird control staff at Manchester Airport, approximately 10% of strikes arose from groundstaff, the remainder being from pilots (Table 1). This figure is similar to that reported from other airports in Britain. Since the establishment of a Bird Control Unit, over 50% of strike reports have arisen from groundstaff.

Table 1: The Source of bird strike reports

(* From CAA 84010, 85018, 86006)

Airport	Year	% reported by ground staff	Total no. strikes
UK airports	*1982-84	10%	1073
Manchester	1982-84	11%	123
Manchester	1985-88	52%	114

This variability arises directly from the quality of the established reporting systems and the awareness of those involved of the need for reporting. This awareness must extend to the management of an airport to ensure that they encourage accurate reporting.

3.3 The accuracy of reports

Pilots will often have details about the aircraft, the effect on the flight, the time of day etc. when a strike occurred, but not the species of bird involved. Groundstaff, on the other hand, may know the bird, but not the aircraft or the time of the incident. Engineers often know the effect upon the aircraft, have the bird remains but may have no details about when or where the strike occurred. A high proportion of bird strike reports will, therefore, be incomplete.

It is self evident that complete and accurate reporting of bird strikes is an essential prerequisite to the development of a meaningful and useful data base from which to carry out analysis. The coordination required to ensure complete and accurate reporting again relies upon education of the parties involved and also often, the goodwill and cooperation of the air traffic controllers at the airport.

3.4 The reporting of serious incidents such as engine ingestions.

Civil engine airworthiness regulations relating to bird hazards have required the development of complex and extremely expensive test routines. The way in which a bird of a particular species passes through an engine can result in some cases in no damage and in others to catastrophic failure to the engine. Because of the high costs of testing engines, it is never possible to repeat tests in sufficient quantity to take into account the many variables involved in a bird ingestion, even with the advent of modern computer simulation. A valuable source of information is, therefore, obtained from in-service incidents. This is an area where complete and accurate reporting (in particular, the collection of, and identification of bird remains) is essential, however, there is evidence that some engineers are unaware of the need to retain bird remains for identification. They may not know of the existence of bird remains identification services which are available in many countries (in Britain through the Aviation Bird Unit).

3.5 How representative are reported strikes of the strikes which actually occurred?

The data presented in Table 1 indicate that almost a half of the data available from bird strikes may have been missed due to the fact that the pilot did not know the strike had occurred. While it can be assumed that a number of these may have arisen from 'turbulence' and not actually as a result of the aircraft hitting the bird, there is still a suggestion that a significant proportion of strikes go unnoticed by pilots.

Data from Manchester Airport suggest that some species of bird are more often reported by pilots (as opposed to being found by groundstaff) than others (Table 2). If this tendency were to be repeated in other data sets then it would suggest that underreporting within the bird strike system is resulting in a bias in favour of some species and against others.

Table 2: The percentage of strikes reported by pilots as opposed to ground staff according to species of bird involved.

Type of bird	*% strikes reported by pilots*	*Sample size*
Lapwing	*86%*	*7*
Black-headed gull	*66%*	*29*
Kestrel	*43%*	*7*
Swifts	*33%*	*9*
Swallow	*33%*	*6*
Skylark	*30%*	*13*
Pigeons	*25%*	*8*
House martin	*0%*	*4*

A number of factors could make some birds more or less likely to be noticed or reported by pilots. These are likely to include the size of the bird, its behaviour, the time of day or night when it is on the airfield etc.

3.5.1 Bird size

If strike data are grouped according to the body size of the bird involved, the majority of strikes which were missed by pilots are found to be amongst the lightest birds (Table 3).

Table 3: The influence of body weight upon the likelihood that a strike would be reported by a pilot as opposed to groundstaff.

Body Weight (grams)	Report pilot	Source ground	% pilot
401 - 1000	5	4	56
201 - 400	19	10	66
101 - 200	11	5	67
51 - 100	1	3	25
0 - 50	9	27	25

3.5.2 Flocking behaviour

It would seem logical to assume that a pilot would be more likely to notice a strike if he had seen birds in the vicinity of the runway. A priori, therefore, it would seem likely that strikes involving a bird from a flocking species would be more likely to be noticed by a pilot than birds which tend to be solitary. Amongst the strikes reported through Manchester Airport, 47% of those involving flocking species were reported by pilots, while only 25% of those involving solitary species were reported by pilots.

3.5.3. Other behavioural and morphological factors

Other factors which make certain birds more likely to be noticed by pilots may include the colour of their plumage and whether they tend to spend a lot of time flying over, or sitting on the runway.

3.5.4 Environmental factors

Time of strike (day or night), visibility and weather conditions can all influence the likelihood of a pilot noticing or reporting that a strike has occurred. If the nature of the bird hazard (the species of birds on the airfield) varies according to these variables, then this will lead to a sampling bias.

Amongst 41 gull strikes from Manchester Airport over the past four years, 52% of those recorded during the period from dusk to dawn were reported by groundstaff, whilst only 22% of those recorded in daylight arose from this source. This would imply that better visibility may result in a better chance that a pilot would notice that a strike had occurred.

4. THE INTERPRETATION OF BIRD STRIKE STATISTICS

4.1 The bird strike total

The bird strike total for a particular airport is dependant upon the following factors:

1. The extent and nature of the bird hazard
2. The quality of bird hazard management
3. The number of movements and types of aircraft
4. The quality of the bird strike reporting system

All these factors must be taken into account when assessing the bird strike risk for different airports. However, the bird strike total, or bird strike rate for a particular airport is one of the most oft quoted statistics in publications. Aside from the sources of bias in strike statistics discussed above, these simple statistics tell us very little about the nature of the hazard on the airfield.

The most obvious limitation in this bald statistic is the species of birds involved. Some airports may report a large number of strikes most of which involve small birds such as skylarks (Alauda arvensis) whilst others may report only a few strikes (which may be multiple strikes) most of which involve flocks of larger birds, such as gulls (Larus spp.) and lapwings (Vanellus vanellus).

4.2 How representative are bird strike statistics of the local bird hazard?

A complete analysis of the bird strike statistics from a single airport can give an indication of the time of year, time of day, weather conditions etc. in which strikes are most frequently reported as well as the species of birds involved. However, this information is still of limited value if viewed in isolation.

The frequency with which a particular species of bird appears in bird strike statistics is a function of the numbers found in the vicinity of an airport, their behaviour, and the extent to which they are noticed by pilots (see above).

Starlings (Sturnus vulgaris) feature in a significant proportion of bird strikes reported in Europe and North, America and, indeed, were responsible for the crash of the Lockheed Electra in 1960, an incident which resulted in 62 deaths. Starlings are small birds (85 gms) which, if hit as individuals are unlikely to cause major damage to a transport size aircraft. However when hit in large flocks they are extremely dangerous.

At Manchester Airport, starling strikes are reported throughout the year, however, the extent of the hazard posed by this species is not consistent through the year. During the summer months many starlings are found nesting in hangars and airport buildings, in the latter part of the breeding season, they are restricted in the area over which they can collect food, since they have to return to the nest to feed their young. Under these conditions, several hundred birds flying alone may repeatedly cross the runway. Strikes are not infrequent, but tend to involve only a single bird. In contrast, during the winter months flocks containing tens or hundreds of thousands of birds fly across the runway a dawn and dusk en route to and from a nearby night roost (which has now been dispersed!). Here, for only a few seconds each day, the birds may cross the path of an approaching aircraft, yet if a strike were to occur, the result could be extremely serious.

4.3 National and international bird strike totals

Bird strike data are often amalgamated from a number of airports, or even a number of countries without due attention being given to the individual conditions which pertain at each airport. From the viewpoint of the individual airport, this practice may at best have limited value and at worst be misleading.

For example, while two apparently similar airports may record the same number of strikes involving gulls, at an inland site, such as Manchester Airport, this could be associated with the presence of a nearby winter roost, whilst at coastal airport it could result from the presence of a breeding colony which is only occupied during the summer months. Amalgamating data from these two airports would imply a year round hazard at each.

The value of data amalgamated from different airports lies in the fact that they provide pointers for the way in which resources (for example for research into ecology and behaviour) should be allocated at a national level. It is evident that throughout much of western Europe, gulls and lapwings appear very frequently in bird strike statistics, so these two groups of birds should receive particular attention in any proposed scientific studies.

5. *CONCLUSIONS*

Despite a number of shortcomings in the collection of, and presentation of bird strike statitics, these data can provide a valuable insight into the bird hazard. However, the limitations of these data must be recognised and it is essential that during the development of a bird hazard management programme for an airport, the bird strike statistics are viewed in association with field observations on the movements and behaviour of the birds at that site.

ADF 616037

First ICAO Bird Hazard Reduction Workshop Mexico-City, 5-9 October 1987

(Jochen Hild, Germany)

FIRST ICAO BIRD HAZARD REDUCTION WORKSHOP MEXICO-CITY, 5 - 9 OCTOBER 1987.

A total of 34 delegates coming from 12 countries of the Carribean/South American Region as well as from ICAO, IATA, IFALPA and BSCE attended the workshop.
Most papers presented (24) were given by participants of North America and Europe, dealing with birdstrikes, birdstrike reporting, birdstrike statistics, serious accidents, land-use in and around airfields, biological management on airports, radar observation, organisation of committees, laboratory investigations, wildlife control and ecological problems.

Some delegates expressed satisfaction about the workshop, some others regretted the absence of important countries like Brasilia. Some recommendations for the countries of the region were given:

- Organisation of a comprehensive reporting system,
- Distribution of all papers to all countries who were unable to attend the workshop,
- Revision of Annex 14 of the ICAO handbook to also regard special problems of the region,
- Stronger cooperation and exchange of information between the countries of the region and North America as well as Europe,
- Availability of movies, videos, maps etc. for education and information purposes in further workshops,
- Participation of more local biologists from the region.

For the North American and European participants the workshop was not as satisfactory because there was a lack of understanding for these special biological problems among the participants from the region, and additionally there was a lack of coordination between BSCE, ICAO and regional countries. So many problems were over-discussed, others were presented too academically regarding the fact that most participants of the region were not competent in biological problems.

Besides that there were difficulties with a constantly changing agenda as well as with organizing a visit to the airport of Mexico-City. All these problems had to be solved during the meeting insteadd of before the meeting.

Therefore the German delegates in BSCE formulated some proposals for organisation and coordination of future workshops and send them to the Ministry of Transport to be forwarded to ICAO. These proposals are:

1. All delegates of participating countries should prepare a more or less brief lecture on the local birdstrike situation regarding the ecological background of their countries.
2. The regional ICAO Offices should invite scientists/biologists of the country, asking them for presentations e.g. about bird movements, dynamics of bird populations as well as about special ecological problems in their region/country, in order to enable the guest-participants to understand the problems and to give advice.
3. BSCE participants should avoid to make their lectures too scientific in wording and biological information; a more popular language and wording would favour the understanding.
4. A visit program (airport, institutes) for illustration of the local situation should be prepared before the meeting; it is important to enable the American and European participants to better understand local problems. These visits should take place at the beginning of the workshop.
5. Better coordination between the participants of BSCE is essential so that reports given can be harmonized before and not during the workshop. To do so it is important to know, who from BSCE with which competence will give which presentation. Such coordination should be handled by BSCE Office or ICAO Headquarters. Moreover the lecturers should be aware of the fact that the practical and operational viewpoint of a single problem is more important than the explanation of complicated scientific interrelations.
6. In future workshops lecturers should make more use of audiovisual aids such as movies, slides, videos etc.in order to functionning and to improve the understanding, but regional ICAO Offices must provide technical facilities for such demonstrations.
7. ICAO should also consider to invite ECAC, IACA, ICAA and IFATCA to future workshops. At any rate more delegates from worldwide operating carriers/airlines should be invited in order to intensify the connection to operational practice.

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ADF616033

Birdstrikes during 1987

(C. Bakker, Royal Dutch Airlines)

KLM Royal Dutch Airlines	Date 22-03-88

Department : FLIGHT SUPPORT SERVICES REPORT Nr: 006BA

Subject : Birdstrikes during 1987

From : C. Bakker

To : AMS/OL
Hr. C.H. Schoen

cc:

AMS/AD	AMS/LR
AMS/OA	SPL/TA
AMS/OD	SPL/CE
AMS/OV	SPL/CA
AMS/NP	SPL/BE
AMS/NE	NVLS
AMS/DV	RLD/LT

1. General

Total number of detected birdstrikes 1987	89 (100%)
Birdstrikes at Amsterdam Schiphol	31 (34.8%)
at Aerodomes inside Europe	32 (36%)
at Aerodomes outside Europe	25 (28.1%)
en route	1 (1.1%)

2. Lists of birdstrikes at airports during 1986 (see attachments)

T = take-off C = Climb A = Approach L = Landing

3. Number of birdstrikes for KLM per airport 1986

Number of movements*	1987	1986	1985	1984	1983	1982
	Strike/10.000 mov.					
Amsterdam 31 64864	4.8	5.3	3.2	5.6	4.7	5.4
KLM worldwide 89 176.852	5.0	5.6	4.4	5.67	4.14	5.4

* A movement is a landing or a take-off

4. References
1. Pilots birdstrike report
2. Monthly birdstrike survey of Central Engineering Department
3. Actual Program of Logistics Department
4. KLM Insurance Department
   Damage costs without consequential losses approximately $ 156.900,-.

klm 2756-2

KLM	AIRPORTS			PHASE OF FLIGHTS											REGISTRATION, IDENTIFICATION AND COSTS.
DATE	AMS	Inside Europe	Outs. Europe	T	C	A	L	F-27	F-28	DC-9	B-737	A310	DC-10	B-747	
JAN 87															
1	X			X										X	PH-BULL Lapwings $ 27.000,-
1			ROB				X					X			PH-AGH
11			JRO				X						X		PH-DTL $ 3.000,-
18			JRO				X						X		PH-DTC Black kite
20		MAN					X								PH-MAX Sea-gulls
FEB 87															
5		DUS		X				X							PH-KFL
6		FRA		X							X				PH-BDG
MAR 87															
1			BKK				X							X	PH-BUH
6			CMN	X									X		PH-AGF
14		MLA				X				X					PH-DNC Sparrow
17		CDG				X						X			PH-AGC
18			KUL	X										X	PH-BUH
18	X						X					X			PH-AGE
21		ZRH				X	X				X				PH-BDK Lapwings $ 3.000,-
23			LFW	X									X		PH-DTL
31		LHR		X							X				PH-BDB

KLM		AIRPORTS		PHASE OF FLIGHTS											
DATE	AMS	Inside Europe	Outs. Europe	T	C	A	L	F-27	F-28	DC-9	B-737	A310	DC-10	B-747	REGISTRATION, IDENTIFICATION AND COSTS.
APR 87															
2	X						X				X				PH-BDK Pheasant
8			CMN			X						X			PH-AGI
11		LIS		X								X			PH-AGH Swallow
26	X						X				X				PH-BDK
29	X			X										X	PH-BUL Dove
MAY 87															
4			MEX	X										X	N 4548M
9			SIN			X								X	PH-BUK
14			ROB				X					X			PH-AGI Pigeon
15	X						X							X	PH-BUI
16		ARN					X			X					PH-DOB
17	X			X							X				PH-BDK Sea-gull
18			KAN				X						X		PH-DTC
18	X						X				X				PH-BDK Gull
23	X			X										X	PH-BUK
23		BCN					X					X			PH-AGC Swallow $ 1.000,-
25			LOS	X									X		PH-DTA
27		BCN					X					X			PH-AGA Swallow

KLM DATE	AMS	AIRPORTS Inside Europe	Outs. Europe	PHASE OF FLIGHTS T	C	A	L	F-27	F-28	DC-9	B-737	A310	DC-10	B-747	REGISTRATION, IDENTIFICATION AND COSTS.
JUN 87															
1			KAN				X						X		PH-DTA Hawk $ 75.000,-
5		HAM		X						X					PH-DNI Dove
13			LFW	X								X			PH-AGH $ 1,500
21		CDG				X						X			PH-AGD Pigeons
27	X					X						X			PH-AGF
[illegible] 87															
2			EZE				X							X	[illegible]295E
6		SNN				X								X	PH-BUC
8		LHR				X					X				PH-BDA Sparrow
13	X					X						X			[illegible]-AGB Pigeon
17		ZRH				X					X				PH-BDE
21		WAW		X						X					PH-DNL
24	X						X						X		PH-DTB
27		RTM		X				X							PH-CHF Seagull
29		EIN		X				X							PH-KFG Lapwings
AUG 87															
1	X						X	X							PH-KFE Pheasant
3		EIN				X		X							PH-KFE Lapwings
9	X						X							X	PH-BUK
12	X						X				X				PH-BDE

KLM		AIRPORTS		PHASE OF FLIGHTS											REGISTRATION, IDENTIFICATION AND COSTS.
DATE	AMS	Inside Europe	Outs. Europe	T	C	A	L	F-27	F-28	DC-9	B-737	A310	DC-10	B-747	
AUG 87															
21		VIE				X								X	PH-BUN Kestrel
21	X			X										X	PH-BUM $ 27.000,-
22		CPH					X				X				PH-BDC
24	X				X						X				PH-BDD
29	X			X										X	N1309E
31	X						X							X	N1295E Seagull
SEP 87															
1		IST		X								X			PH-AGF
2		EIN		X					X						PH-CHB Woodpigeon $ 200,-
5		NCE					X				X				PH-BDG
7		LIN		X								X			PH-AGK
12	X			X										X	PH-BUO $ 4.500,-
13	X			X										X	PH-BUW Sparrows
14		EIN		X				X							PH-SAD Gull
15	X			X								X			PH-AGD
23		HAM		X						X					PH-DNK Sea-gull
24	X			X						X					PH-DNO $ 3.000,-
30			JED			X						X			PH-AGF

KLM		AIRPORTS		PHASE OF FLIGHTS											REGISTRATION, IDENTIFICATION AND COSTS.
DATE	AMS	Inside Europe	Outs. Europe	T	C	A	L	F-27	F-28	DC-9	B-737	A310	DC-10	B-747	
OCT 87															
10		AGP		X							X				PH-BDB
11			YYR				X					X			PH-AGK
15	X						X							X	PH-BUM $ 2.000,-
19	X						X				X				PH-BDK $ 7.000,-
26			SIN				X							X	PH-BUK
28		IST					X					X			PH-AGI Sea-gulls
NOV 87															
1		ATH			X							X			PH-AGK Sparrows
1	X						X				X				PH-BDE Sea-gulls
4			KUL		X									X	N4551N
4	X			X							X				PH-BDI Blackbird
17	X					X					X				PH-BDI
23			LOS				X						X		PH-DTL
DEC 87															
4			NBO				X							X	N1295E
4		LHR				X	X				X				PH-BDG
9	En route 3000'							X							PH-CHN
10	X			X							X				PH-BDI
12			AMM				X					X			PH-AGA
14			CMB			X	X							X	PH-BUC $ 2.700,-
18	X			X									X		PH-DTD Lapwings
30	X					X						X			PH-AGB Sea-gulls

KLM		AIRPORTS		PHASE OF FLIGHTS											REGISTRATION, IDENTIFICATION AND COSTS.
DATE	AMS	Inside Europe	Outs. Europe	T	C	A	L	F-27	F-28	DC-9	B-737	A310	DC-10	B-747	
DEC 87															
30			YMX	X										X	PH-BUH

ADF616034

Addendum to aerodrome measures book. Some measures used in different countries for reduction of bird strike risk around the airport

(T. Brough, Aviation Bird Unit)

BSCE 19 / WP 37

Madrid, 23-28 May 1988

ADDENDUM TO AERODROME MEASURES BOOK

SOME MEASURES USED IN DIFFERENT COUNTRIES FOR REDUCTION OF BIRD STRIKE RISK AROUND THE AIRPORT

Draft for 3rd Edition March 1988

Revised entries for the United Kingdom

T Brough
Aviation Bird Unit

p.7 Garbage dumps

The "Town and Country Planning (Aerodromes) Direction 1981" requires local authorities to consult the Ministry of Defence or, as appropriate, Civil Aviation Authority concerning development of land within designated areas on or around aerodromes. This covers various bird attracting developments such as refuse tips at landfill sites within 8 statute miles (13km) of the aeodrome. The aviation authorities can advise against certain developments and, if no agreement can be reached, an inquiry could result, leading to a ministerial decision concerning the land usage. These arrangements apply only to planning applications for future developments. Little can be done to close landfill sites already in existence.

p.11 Pigeons

There is nothing to prevent local residents from keeping or rearing pigeons in lofts in the vicinity of aerodromes and releasing them for exercise flights. There are also no legally binding regulations regarding mass releases of birds. There is, however, a satisfactory informal agreement with the Royal Pigeon Racing Association (to which most local clubs are affiliated) whereby large releases of pigeons are banned within 7 nautical miles (13km) of major civil aerodromes. For other civil, and all military, aerodromes, all liberations within 7 miles have to be notified to Air Traffic Control (ATC) 14 days before the date of release and additionally by telephone 30 minutes before release time. For ATC purposes, such releases can be delayed by 30 minutes. This agreement is reviewed annually and works well.

p.14 Use of land

As in the case of landfill sites or refuse tips, the "Town and Country Planning (Aerodromes) Direction 1981" requires local authorities to consult the Ministry of Defence or Civil Aviation Authority concerning applications for possible bird attracting developments such as reservoirs, sewage disposal works, nature reserves or bird sanctuaries within 8 statute miles (13km) of major civil, and all military, aerodromes. Developments such as gravel pits and quarries, which are likely to become expanses of open water or potential landfill sites in the future, are also included.

p.24 Trees and bushes

Trees and bushes are treated as obstacles within areas to which the consultative procedures of the "Town and Country Planning (Aerodromes) Direction, 1981" apply. Matters which cannot be agreed between the aviation authorities and the local planning authority could result in an inquiry leading to a ministerial decision. There are, however, no consultative requirements in respect of possible bird hazards associated with trees and bushes. The latter are often grown on aerodromes to enhance appearance and screen obtrusive buildings. Aerodrome operators ought to be aware from advisory literature of the potential dangers of bird attraction and would be expected by the aviation authorities to take remedial action in the event of problems arising. This might involve the thinning or even total clearance of trees where significant problems have arisen and no alternative solution is possible. Such action off the aerodrome would be subject to agreement with the land-owner.

p.27 sanctuaries

Planning applications for proposed sanctuaries or nature reserves require consultation with the Ministry of Defence or Civil Aviation Authority exactly as in the case of garbage dumps and other land developments which may attract birds and are described earlier. Again, there are no legal requirements regarding existing sanctuaries or nature reserves.

p.33 Length of the grass

Long grass is recommended as a bird deterrent at civil aerodromes with paved runways. Grass within 5m of such runways should not be longer than 10cm, but elsewhere a maximum of 20cm is suggested. Specialist advice should be obtained before adopting a long grass policy at any aerodrome. General advice is provided in paragraphs 4.3 and 4.4 of the document issued by CAA to UK airport operators entitled "Bird Control on Aerodromes" ref CAP 384. Similar practices are to be found on military aerodromes. The control of weeds, which are a source of food for some birds, is included in the recommendations for the maintenance of areas devoted to grass.

p.37 Chemical repellents

No chemical methods of repelling birds are used and none is known to be suitable.

New entry - concerns use of chemicals but not as a repellent. Proposed title **Bird population control**

In exceptional circumstances, herring gulls Larus argentatus and great black-backed gulls L. marinus breeding on an aerodrome and on an air weapons range have been stupefied on their nests by baiting with alpha-chloralose and seconal and subsequently killed. This work has been carried out under government licence.

New entry - concerns use of chemicals but not as bird repellents. Suggested title **Chemical control of invertebrate food sources**

On a very few occasions when craneflies (Tipulidae) have attracted birds to aerodromes, they have been treated with insecticide. Chlorpyrifos has been used now that DDT is banned. Less frequently lumbricides have been used to kill earthworms but no details are known.

p.42 Bird sounds

Great reliance is still placed on the use of recorded distress calls. A variety of compact cassette in-car equipment is used.

p.43 Bird sounds but should perhaps be headed "Acoustic devices"

Ultrasonic noises in the range of 18-30 kHz produced virtually no avoidance reaction in aviary tests in 1967 with six different species of perching birds. No further work was undertaken.

Synthetic sounds produced by Av-Alarm equipment were tested in the field against several common airfield species in 1968-71. The results were considerably less effective than those produced by distress call broadcasts. Not used on aerodromes.

p.46 Shell crackers

Bird scaring cartridges or shellcrackers are used regularly on most aerodromes. Twelve bore shotgun blanks are sometimes used as a substitute in congested areas near buildings and aircraft, or where shellcracker projectiles might cause a fire hazard.

p.47 Gas cannon (New entry)

Gas cannons are only used at a few aerodromes and are not recommended for general use.

p.51 Falconry

Falcons and hawks are used only at a few military airfields and always in conjunction with other techniques. In most cases these birds are only permitted to fly when aircraft are not operating; eventually this will apply in all cases.

p.52 Birds mock up

Models of gulls (ie skins of herring gulls Larus argentatus and lesser black-backed gulls L. fuscus mounted by a taxidermist in realistic attitudes) were found neither to repel nor attract common gulls L. canus on an aeordrome.

Life-size silhouettes of black-headed gulls L. ridibundus, common gulls and herring gulls with wings outstretched and cut out of 25mm polystyrene sheet and then painted, had limited scaring effect on

gulls when scattered on a loafing site by a refuse tip. Trials with silhouettes of lapwings Vanellus vanellus made in the same way and placed on an aerodrome proved unrewarding.

p.57 Visual scaring

The slow waving of an operator's arms, as though to simulate the wing beats of an eagle, has proved a cheap and effective way of scaring birds and is a useful supplement to other methods.

Stringing wires across small bodies of water has on occasions been successful in deterring gulls and wildfowl. An array of wires has also been used to prevent gulls from feeding on a circular filter bed at a small sewage treatment works on the edge of an aerodrome.

A static searchlight and a searchlight mounted on a vehicle have both proved useful in scaring gulls from an aerodrome at night.

p.63 Organisation

The Civil Aviation Authority expects that a senior member of the aerodrome management/operations staff will be responsible for bird control organisation, co-ordination of operator training, and supervision and maintenance of records of operational and incident data.

For civil aerodromes, procedures are covered in detail in the CAA Publication CAP384 "Bird Control on Aerodromes" which is the main guidance document. Civil aerodromes which are licensed by the Civil Aviation Authority are required to produce an Aerodrome Manual which is designed to instruct the aerodrome operating staff as to the procedures relevant to their duties. The Manual must demonstrate a reasonably effective system for bird detection, deterrence and dispersal in relation to the scale of the bird problem and the type and level of air traffic at the aerodrome.

Some assessments of the adequacy of bird control practices are made by the CAA aerodrome inspector during licensing inspection visits. Occasional visits to review bird problems and their control and to

give advice are also made by the Aviation Bird Unit (ABU) when requested. The CAA provide courses for civil aerodrome personnel at which instruction is given by the ABU on aerodrome bird control.

On the military side, the RAF has Bird Control Units (BCUs) at all airfields which are regarded as "high risk". The BCUs generally consist of about three men using distress calls, bird scaring cartridges and, in extreme cases, a shotgun. The units are established with their own Land-Rover and are under the direct supervision of the Senior Air Traffic Control Officer (SATCO) who is responsible to the station commander for the operational status of the airfield. Group and Command headquarters supervise individual airfield operations.

All RAF BCUs are progressively being "civilianised", ie their duties are being taken over by private contractors, each for a five year term. This exercise is organised by the Central Bird Control Co-ordinating Officer (CBCCO) in the National Air Traffic Services (NATS). The CBCCO has overall responsibility for bird control practices on military aerodromes in the UK and obtains advice and assistance from the ABU on specialised matters.

p.69-70 Appendix 1 : Persons

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ADF616035

Some proposals for evaluations of bird strike data

(B. Bruderer, Swiss Ornithological Institute)

BSCE 19 / WP 38
Madrid, 23-28 May 1988

SOME PROPOSALS FOR EVALUATIONS OF BIRD STRIKE DATA

B. Bruderer
Swiss Ornithological Institute

Summary

The paper emphasizes the importance of careful evaluation and interpretation of statistical data. With respect to recent comparisons of the strike rates at different airports it is proposed, that, if airports are to be compared, the data should be based on the strike rates of individual operators. Conclusions should only be drawn if the results of different operator show a similar pattern.

SOME PROPOSALS TO THE EVALUATION
OF BIRD STRIKE DATA
PRESENTED BY B. BRUDERER

INTRODUCTION

Publications like "Analysis of Bird Strikes Reported" (Thorpe 1984, BSCE/WP17) try to evaluate the available data as carefully as possible. In spite of the many precautions taken they are biased in different ways. Some of the distortions are not harmful but others are dangerous. It is not bad for our purpose that collisions of large birds are overestimated compared to those with small birds; it is not so important that strikes off the airports are underestimated compared to those on or close to airports. However it is dangerous when some airports are blackmailed by high numbers or rates of strikes, if these do not correspond to reality.

Thorpe´s 1984 papers give strikes rates per country. Most are below 3 per 10,000 movements.Germany showed up with 8.7 Switzerland had by far the highest rate with 10.5 strikes par 10,000 movements. Thorpe indicates that "although each country is reporting strikes world-wide, a high proportion of its aircraft movements are within its own country and its record will thus be affected by its own birdstrike problem".

This last conclusion, however, covers only a minor part of possible explanations. It is not stressed at that time that the strike rate per country reflects primarily the effectiveness of reporting systems of that country:10,5 strikes per 10,000 movements is nearly equal to the strike rate of Swissair world-wide.

The result of the 1984 analysis showed an even worse picture when the strike rate of national airlines was related to selected airports. Both Swiss airports Zurich and Geneve, were far at the top, what is again the result of the efficiency of SWISSAIR reporting system.

The only possibility to avoid such misleading results is the evaluation of strike data per operator. The result of SWISSAIR strike data of the years 1985/86 are an example of how to do it. They show clearly that doing the analysis by operator puts the Swiss airports well within the range of other airports.

Very high rates come out for Rome and Amsterdam. At this point we have to avoid another quick and possibly wrong conclusion. Only when other within operator analysis show the same general pattern, conclusions can be drawn and measures proposed.

The conclusion is, that, for a valuable comparison of different airports it is necessary to have evaluations per operator, giving the strike-rates of these operators per airport. This special evaluation implies, that the number of movements for the airports in question are given by such operator. For airports with low numbers of movements figures should only be given covering several years, so that at least 1,000 movements are reached. Otherwise overrating of rare events could again lead to misleading interpretations.

ADF616036

Robin, the new bird extractor on relaf long range surveillance radar

(L.S. Buurma and M. W. Ockelorn, Es The Hague)

BSCE 19 / WP 39

Madrid, 23-28 May 1988

ROBIN, THE NEW BIRD EXTRACTOR ON RNLAF LONG RANGE SURVEILLANCE RADAR

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Summary

ROBIN stands for Radar Observation of Bird Intensity and Notification. It is the acronym for the successor of KIEVIT, the Dutch electronic counting system at work since 1978. It consists of a computer configuration with hardware and software modules. Using pattern analysis algorithms, it processes digitized raw video into synthetic bird video. Functions are arranged in software as much as possible, to keep open the option of future improvements. The system is designed to serve as an operational instrument as well as research tool. More details will be included in the booklet "The Application of Radar for Bird Strike Reduction" to be issued during the second half of 1988.

3.2. Work done during the meeting

- The following papers nicely combined the technical and biological aspects of radar ornithology, going from large to small scale:
  a) R.P. Larkin illustrated the fascinating capacities of pulsed doppler weather radars for bird detection in combination with modern computer technology. Dedicated software is presently in preparation for the Next Generation Weather Radars (NEXRAD) for the USA.
  b) L.S. Buurma showed a series of slides explaining the echo pattern analysis within the new Dutch bird extractor ROBIN, becoming operational this year.
  c) The small scale observations by tracking radar in Switzerland (B. Bruderer) have now reached a stage where bird tracks and bird numbers can be directly fed to a personal computer.
- The second sequence of papers switched to more biological (field) work:
  d) B. Larsson told about Swedish expeditions to Greenland where field observers and a big radar station revealed spectacular flights across the inland ice towards WNW and ESE.
  e) B. Bruderer reported on radar observations at six sites in southern Germany and Switzerland.
  Rather constant headings resulted in southward deviating tracks under the influence of the frequent westerly winds in southern Germany, while in the Swiss lowlands the birds flew WSW.
  f) Nocturnal observation of migrating birds up to two kilometers by means of a new technology, thermal imaging, demonstrated surprisingly new possibilities for wildlife studies. This heat camera was used by L.S. Buurma in combination with a tracking radar

- Report from other countries
  g) Germany reported the continued use of polaroid photos. A video tape nicely illustrated the additional filming system on some airport radars.
  h) The BOSS system in Belgium is still working as reported in Copenhagen enlarging their reference data set.

i) USA: After a serious multiple bird strike with a Galaxy at Dover Air Force Base the USAF evaluated several radar types in order to monitor permanently bird movements. A GPN 20 fan beam radar was selected.

j) Denmark: the FAUST system is still in operation at three radar stations.

k) Norway continued to use polaroid photos at three ATC radars.

l) Finland: Visual and radar observation has been used operationally in cooperation with Estonia.

m) Israel: Realtime warnings to pilots are given on the basis of radar data from Ben Gurion airport. Altitudes and routes of soaring birds are studied by means of a motor glider.

- Special discussion on a dedicated bird radar

A number of specialized working group members formulated design criteria for a small pencilbeam radar (side view range for a gull (G 100 cm^2): 10 km) fully dedicated to bird detection and quantification in three dimensions. The need for such an automatically operating instrument has been stated already in the early seventies, but ideas were divergent. Now, the agreement is surprisingly full. The bird radar should serve, in the first place, at locations with a clear bird problem such as certain airports and shooting ranges. Combined into networks they also could monitor large scale bird migration. Finally, they can help to calibrate the bird countring systems at existing larger radars. The booklet "The Application of radar for bird strike reduction" will contain a chapter on this important agreement.

4. RECOMMENDATIONS

a) International cooperation with respect to further development of electronic assessment of bird hazards by radar should be intensified.

b) When quantifying bird movements, emphasis should be put on the proper inclusion of bird numbers at low level.

c) The industry should be approached to develop, commercially, a small bird radar according to BSCE specifications.

Luit S. Buurma & Bruno Bruderer

ADF616037

Electronic recording of bird tracks and bird numbers by tracking radar

(B. Bruderer, Swiss Ornithological Institute)

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Madrid, 23-28 May 1988

ELECTRONIC RECORDING OF BIRD TRACKS AND BIRD NUMBERS BY TRACKING RADAR

B. Bruderer
Swiss Ornithological Institute

Summary

The tracking radar "Superfledermaus" can be used in a tracking as well as in a surveillance mode. The flight paths of automatically tracked birds are digitized and recorded at intervals of one second by a personal computer. The same computer also stores a reduced and digitized picture of the PPI, while the pencil-beam of the radar rotates around a vertical axis at selected elevation angles.

Formerly, individual bird tracks detected by tracking radar have been recorded by two-channelled XYY'-plotters. Measuring track directions and calculating headings were done afterwards by hand or by simple computer processing. Numbers of birds were extracted from photo-records of the plan-position indicator or the range-height indicator. The echoes on the photos were digitized and related to the air volumes surveyed in order to get bird density; all these evaluations were very time-consuming. The high speed and large capacity of actually available personal computers offer us new, efficient and relatively cheap recording techniques. The object of this paper is to describe briefly our computerized recording technique, and to highlight some problems of evaluation.

The system is based on an IBM PC (AT). The data which previously went to the XYY'-plotter are now digitized and transferred at intervals of one second to the computer. In addition to the three coordinates, we store the date, time, the running number of the bird within a night, the reference to the magnetic tape on which we record the echo-signature, the bird category and the wing-beat frequency (quickly estimated from the echo-signature). Every four hours we track a pilot balloon to determine the winds at various heights. After a night's observation, we are able to show selected flight paths on the screen and compare them in detail with the echo-signatures. The computer also calculates reduced sets of data:
a) for intervals of 20 seconds the approximate speed, flight direction, heading, height, as well as the correlation coefficient of the approximation;
b) the same approximations for a whole bird track. The last set of data leads to a rough survey for each night, giving the distribution of all the track directions and headings, ground speeds and air speeds at selected height bands. A yet unresolved problem is the separate recording of echo-signatures. In spite of Fourier transformations improving the determination of wing-beat frequencies, we must still visually inspect the complicated pattern of echo-signatures.

The quantitative data previously extracted from PPI- or RHI -photos are now also transferred directly to the PC. The area around the radar is scanned at six elevation angles. A measuring window scans up and down the rotating pencil-beam about four times within each degree of rotation.

The energy level contained in each resolution cell is sampled. In order to reduce the amount of data, only the average of 10 scans is stored. This averaging has the advantage of increasing the signal to noise ratio, but also a disadvantage in that a bird echo will be confined to about 3 to 4 stored scans. The information on the form of the single echoes becomes minimal. If two birds are separated from each other only by 100 to 200 m at larger distances they can only be discriminated if two distinct intensity peaks appear. Another unresolved problem is the exclusion of insect echoes at short ranges. Two further difficulties could be successfully handled in the following way: 1) The ground clutter is excluded by adding all the records of a season for each elevation. As ground clutter appears with a high degree of constancy in certain resolution cells, the latter can easily be defined and excluded by a simple threshold procedure. 2) Electronic detection of weather echoes is more difficult than detection of ground clutter. As our studies are not planned to be fully automatic, we decided to delete cloud and rain returns interactively: the metereological echoes are clearly recognizable on the radar screen (raw video). Thus, it is the task of the operator to indicate with the help of a "mouse" directly on the computer screen the areas to be considered as clutter and to be excluded from further calculations.

The available array gives us the possibility:

1) to describe the flight behaviour of a sample of 100-300 birds per night (according to the selected length of the single tracks),
2) to compare it to the wind situation at different height intervals,
3) to give at least relative numbers of birds per unit volume of air space at different altitudes. Combining the two sets of data leads to a fair estimate of the height distribution of birds and their flight behaviour at different altitudes.

ADF616038

Means and methods of bird number reduction within the airport area

(V. Ya. Biryukov, A.I. Rogachyov, E.E. Shergalin, URSS)

BSCE 19 / WP 41
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MEANS AND METHODS OF BIRD NUMBER REDUCTION WITHIN THE AIRPORT AREA

V.Ya.Biryukov, A.I.Rogachyov, E.E.Shergalin
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The airport of Tallin serves as an illustration of some bird hazard specifical features in airports. The methods of the hazard investigation are described. The efficiency of different measures is analysed directed at elimination of the causes of bird concentrations as well as at their timely detection and scaring. Major characteristics of various acoustic systems designed for the last three years are considered.

The problem of bird strike prevention remains urgent for the USSR civil aviation. In 1987 393 strikes were registered which caused significant material damage and in some cases created a real hazard for aircraft operation.

Incidents connected with birds take place in some 100 airports of the USSR. However, often they are registered in 10 to 15 airports only, mainly in the vicinity of the Black Sea and the Baltic Sea shores. The authorities of the airports mentioned carry out intensive work directed at reduction of bird strike hazard and based on acologically "soft" methods excluding killing of birds.

The contents and efficiency of the work may be illustrated by Tallin airport where it is particularly active.

The airport is situated at the Baltic Sea shore, in the region of complex ornithological conditions. The probability of bird strikes here is 10 times greater than the average around the country.

The paths of mass bird migrations pass over the aerodrome itself as well as over the Gulf of Finland lying 2-3 km from it. The aerodrome is surrounded by the objects attracting large numbers of birds: a lake, a canal, ponds, quarries, a meat products factory, a poultry plant, a fur farm, a granary and cultivated fields. Thousands of birds fly over them daily. For a long time the most numerous among them were lake-gulls. Some years ago hundreds of them rested on the airfield in bad weather or after feeding at a dump 1.5 km from the aerodrome. In 1976 the dump was moved 14 km away on the request of the airport authorities. However, since then the number of gulls on the lake 250 m away from the runwat began to increase. In five years their number increased six times and they started flocking at the aerodrome again.

Consequently, in 1980 the airport personnel began to collect eggs at bird settlements on the recommendation of scientists and with the permission of the State Animal Protection Society. By 1986 it resulted in four times reduction of young gulls population. Part of the colony moved to another site, more distant from the airport.

Besides that, the construction of a dike began in the vicinity of the bird colony on the lake. The dike at once became the main site of their rest and overnight stops instead of the runway where they had gathered earlier. Some part of the birds began to gather at night at an asphalt-paved site for special purpose vehicles. From May to July up to 3000 gulls stayed there overnight attracted by the absence of people, a high fence and lighting. It is worth noting that several couples of gulls started nesting there yearly on the vehicles unused.

In 1986, after the dike on the lake had been constructed, all the gulls moved to the lake's part distant from the aerodrome. However, by this time the number of other birds within the airport area had increased greatly, particularly of crows, pigeons and ducks, which led to intensification of measures directed at making the aerodrome territory less attractive for birds. The

measures included shrubbery cutting out, boggy strewing, water reservoirs drainage, stretching of ropes with red flags over fire ponds, mowing down the grass up to IO-I5 cm height, etc. Gas acoustic guns, plastic balloons with stereo images of an eye of a bird of prey and mirror balls were installed at the sites of probable bird gathering. The measures listed permitted to preclude continuous presence of birds at the aerodrome. If the birds gathered there for a short period of time they were scared by flare pistols, guns and a stationary bio-acoustic system, the only one in the country. Great importance was attached to observations of bird movements hazardous for aircraft. To this end in I980-I987 about 3000 gulls nesting on the lake were ringed. Consequently more than 70 of them were registered at wintering sites of various countries of Western Europe. In I986 several dozens of lake-gulls were caught and painted. Observations revealed that lake-gulls flied for feeding as far as 25 km.

Since I980 observations of bird migrations have been carried out with the aid of airport surveillance radars. In case of bird detection the information was quickly transmitted to the crews of the aircraft within the airport area. According to the recommendations of the I6th and the I7th BSCE Meetings, from I6 to 3I May, I986-I987, Helsinki-Vantaa airport was informed on mass waterfowl migrations by the radio. Concurrently with the observations mentioned statistics on near-collisions of birds with aircraft was collected, particularly for heights of more than I000 m.

Since I986 short-term forecasts of bird migrations have been produced based on their dependency on 20 different meteorological factors. The dependency resulted from long studies.

Special attention has recently been payed to testing of new bio-acoustic systems for scaring birds in different situations. In I983 one of such systems named "Bars" with power supply from a vehicle battery was developed and tested. Its effective range was more than 500 m. Technical and operational performances of the system were presented in a Soviet delegation report at the I8th Meeting in copenhagen. High electroacoustic characteristics of "Bars" resulted from manual adjustment of several assemblies which made it inacceptable for industrial production. To optimize the requirements to production samples "Bars" was tested together with a special signal processing block limiting the frequency range at the level of 3 dB with the slope of I2 dB/oct at minimum steps of 0.2, 0.4, 0.6 and I.0 KHz and maximum steps of I0, 8, 6 and 4 KHz.

The processing block permits to introduce frequency pre-distortions, higher than I Khz with positive amplitude-frequency slope of I.5, 3.5, 5.0 and 7.0 dB/oct, to descretely compress the dynamic range with the aid of inertial and non-inertial compressors and a limiter at the level of 3, 6, 9 and I2 dB. It should be noted that the block characteristics were determined by way of spectral analysis of the signals of birds hazardous for aircraft, first of all gulls and crows.

Introduction of frequency pre-distortions with the positive slope permitted to compensate significant attenuation of high-frequency components resulting from the medium viscosity,

molecular absorption ans the atmosphere turbulence. Grequency pre-distortion values were selected on the basis of the bird signal energetic spectrum pattern and the distance.

To increase the system range in conditions of the airport high noise background without nominal output power augmentation it appeared reasonable to compress the signal transmitted and in some cases to clip it. The results of the tests showed that the frequency range limitation of 0.6-0.8 KHz did not influence bird scaring efficiency. Moreover, introduction of non-inertial compression at the level of up to 9 dB and frequency pre-distortions with the positive amplitude-frequency slope of 3.5 dB/oct when broadcasting at a distance of 2000 m increased the scaring efficiency due to signal/noise ratio augmentation and the signal being natural at the point of its reception. The above mentioned was taken into account when developing a production prototype "Berkut" produced since I988.

To scare birds in vast areas another version of the mobile bio-acoustic installation was developed with total output power of I.2 kW. The installation comprises two acoustic systems consisting of I2 horns 50 W each. The acoustic systems are fixed on both sides of a vehicle perpendicular to its movement direction. This permits to cover a vast territory, to avoid air sucking into the horns, and the Doppler effect arises as well. To support the acoustic signals the vehicle flash lamps are used operating in random mode or timed with acoustic signals.

To scare birds in inaccessible parts of the airport a portable bio-acoustic system was developed, its weight being I8 kg. It consists of a tape-recorder, an amplifier with maximum output power of 75 W, a battery of I2 V and a horn. The electroacoustic bandwidth is 0.5-7.0 KHz, maximum sound pressure at a distance of I m on the acoustic antenna axis - I30 dB. The system can be powered by the vehicle battery with simultaneous recharge.

A compact portable bio-acoustic system has been developed and is tested now, its weight being about 6 kg. Instead of a tape-recorder a repellent signal synthesizer is used permitting to imitate species characteristics of the bird repellent signals and to transmit "discomfort" sounds.

Intensive and regular complex measures for bird hazard reduction in Tallin airport permitted to decrease the number of bird strikes with aircraft almost two times.

ADF616039

Self-contained portable laser transmitter

(J.D. Soucaze-Soudat, France)

BSCE 19/ WP 42

Madrid, 23-28 May 1988

SELF-CONTAINED PORTABLE LASER TRANSMITTER

ABSTRACT

The international civil aviation organization recorded in I985 4045 reports on birds impacts from 45 countries. Most of the impacts have occured on airports or to their vicinity.
Fourty nine percent of their occured at less than 30 meters from the ground and sixty two percent at less than I50 m (one hundred and fifty meters)
If we look carefully at diagram I it can be noticed that all collisions, near the ground, are due to birds surrounding the landing strips. Relevant airport Security people have to send the birds away from these dangerous areas.
Various means are used: falconry, fire of explosive cartridge, diffusion of recorder sounds through loud-speakers, rigorous control of agricultural areas, etc.....

In addition to these methods, it appears today that birds can be scared away with the use of a new device.

TECHNICAL PRESENTATION OF THE NEW DEVICE

This new device was first developped for remote-control in mountain environnement in order to release snow avalanches preventively, it is a self contained portable laser transmitter composed of:

- I Helium-Neon laser tube
- I Beam enbarger telescope
- I Optical sighting device
- I Electrical supply with a transport bag
- I Temporary electrical commutation

The main originality of this equipment is that it is possible to adjust the sighting devices in order to have a perfect parallelism between the optical sighting line and the straight line emitted by the laser beam.

The aim of the telescope, set at the extremity of the laser tube is to reduce the divergence angle of the beam.

The spot sent out is about 2cm round when it comes out of the equipment and about 6cm at a distance of I kilometer.

The beam brightness varies as well according to the distance existing between the impact and the équipment. Recent measurements have been made and specific technical diagrammes established.

There is only one specimen of this equipment, developped as a prototype. It corresponds exactly to the regulations of " French Norme" NF C 43-80I which defines the radiation security of laser equipments. The classification is III A

EQUIPMENT APPLICATION

We have been making several tests since December I987, with Mister LATY, who is an ornithologist depending on the general delegation of French Civil Aviation.

First tests were made at the Tarbes-Ossun-Lourdes airport and we have had very good results on various birds such as: buzzards, lapwings, etc ......

ADF616040

Thermal imaging, a new remote sensing technique for nocturnal wildlife studies

(L.S. Buurma, Es The Hague)

BSCE 19 / WP 43
Madrid, 23-28 May 1988

THERMAL IMAGING, A NEW REMOTE SENSING TECHNIQUE FOR NOCTURNAL WILDLIFE STUDIES

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INTRODUCCION

It is one of the aims of the radar working group to discuss all possible means for remotely sensing bird movements. Besides radar some other techniques have been tested for the observation of nocturnal migration and were reported here. Portable infra red goggles combined with IR illumination have already reached the third generation and are frequently applied in biology. Light amplification is the other candidate that attracted attention during the last two decades. Especially the approach of Gauthreaux (1979) who later combined small radar and light amplification within a spotlight beam, appeared to be succesful. Here I report on some preliminary observations with a new challenging technique: thermal imaging.

THE THERMAL CAMERA

The thermal camera or heat picture camera converges thermal radiation (deep infrared, 812, µm wave length) by means of a germanium telelens. The image is scanned horizontally and vertically towards a cooled (-193 degrees Celsius) heat sensitive detector. This detector transforms heat differences (wave length differences) into electric signals, which are used to produce normal video. The grey tones on the TV monitor show heat differences as small as 0.1 degree Celsius.

EXPERIMENTAL SET-UP

During a radar study in october 1985 I had the opportunity to test during one week a new thermal camera of Philips Usfa, type UA 9053. It has a 300 mm germanium lens with a viewing angle of 3 degrees. It gives an image field of 25 x 40 meter at 1 km distance. The camera was mounted parallel to the tracking antenna of a Flycatcher radar (A product of Hollandse Signaal, again Philips): fig. 1. By using the operation facilities of the radar system we could direct

the thermal camera in all directions and register them precisely. The camera was used alone and in combination with automatic radar tracking. The tracking data from the radar computer were processed in a special cabinet in order to store them and to produce flight path plots. It was also possible to videotape the thermal images and radar data in an integrated form: fig. 2.

The image of figure 2 shows a farmer who is loading a lorry at night at 700 meters from the radar. The grey tones of the digger beautifully iullustrate the heat radiation: warm hydraulic lines are visible through the metal housing of the grasping arm. The relatively cold grab bucket is virtually invisible because it has nearly no thermal contrast with the nocturnal air. Warm wheel axes and hot air outlet cause the dark tones. The farmers bared head radiates the most heat, while the overlap between his coat and trousers shows the smallest heat loss.

The information on top the image deals with date, time and run number (radar track number). The second line on top indicates the real radar data that are renewed each second. The figures at the bottom line are the calculated flight path data for the tracked target: coarse, speed, altitude and diving angel. In this particular case we selected the azimuth / elevation direction manually.

RESULTS

Termal images in combination with radar tracking: Hundreds of birds tracked at night were simultaneously viewed with the thermal camera. Figure 3 gives an example: a flock of medium sized birds. The most common migrants appeared to be Turdus spp. , as was indicated by

1) flight calls noted by humans;
2) wing beat patterns derived from fluctuations of the Automatic Gain Control (AGC) of the tracking radar; and,
3) wing beat counts directly from the heat picture video tapes (frame by frame analysis - see below).

Migrants approaching the radar were often locked by the radar before their thermal image exceeded noise level. Usually Thrushes became visible on the monitor at distances of around 1 km. This maximum distance increased in the coarse of the night up to approximately 2 km. as a result of the decrease in air temperature. Lower temperatures at high altitude and differences in heat

losses between upper and underside of the birds caused high flying birds to be better visible than low flying ones.

The majority of the songbirds fly spatially dispersed and at night appear as solitary individuals, at least to the camera. When the flight patches of two individuals cross it can directly be seen at what distances the AGC signal of the tracked bird is disturbed. A minority of the nocturnal migrants, mostly larger birds such as waders, ducks and geese, appeared to gly in flocks, sometimes very compact: figure 4 (probably curlews).

A flock of 5 geese (figure 5) (family?), seemed to react to the radar at a distance of 1300 m. Firstly, one bird (mother?) shifted to the left, hundred meters further three birds (young?) flying in close formation, follow this bird and finally the last goose (father?) changes direction also and joins the group.
Having detoured the radar, the flock restores the formation and continues in the original track direction.

Thermal camera used alone: We also used the camera separately , and did so in two ways:

1) scanning slowly along the horizon (each night a few times) looking for low flying birds; by occasion some time was spent to observe mammals like rabbits, deer, foxes, cats, etc. (figure 6)
2) directing the camera to the zenith.

The first method confirmed the impression from radar observations, namely that virtually no nocturnal migrants flew at tree top height. The number of birds on the ground was much smaller than the number of mammals. Judging to the somewhat limited (but still good) visibility of flocks of Lapwings at the runway compared to the very good visibility of mammals, this simply may be a matter of detection range.

Directing the camera vertically upward for one hour during a night with heavy migration provided a beautiful sample of clearly visible "falling stars" at the video tape. Directions could be measured up to 1 degree accuracy. Passage times could be measured up to 1/50 of a second and were transformed into altitude estimated on the basis of the average track speed of migrants during that time from the tracking radar data. Figure 7 is a time photo (1/2 sec) of one passing bird visible at the video tape: 23 video frames cause 23 successive images showing wingbeats (ca 6 Hz).

DISCUSSION

The thermal camera appears to be a very promising and reliable tool, as was reported first by Buurma (1986) and Marti & Heiniger (1987).

Its capacities are only poorly reproduced by the photo's; however, the original video tapes are much better! A detection distance of up to 2 km. for birds flying overhead means that the equipment can serve as a complementary tool for X-band radar studies on nocturnal bird migration. Because birds can be viewed directly, heat images can help to identify the birds tracked by the radar. They offer the possibility to study details about bird behaviour such as flocking and evasive action near obstacles. Also the "behaviour" of the radar with respect of bird detection can be assessed. One point of interest is the fact that insects, in contrast to warm birds, are nearly invisible. In this respect, the technique of thermal imaging differs principally from light amplification and can solve the insect problem for certain radar ornithologists (see Bruderer 1971).

The equipment proved to be very reliable: No malfunction during 7 nights of continuous operation on top of the moving tracking system of the radar. After 1985 the thermal camera has been improved with respect to resolution and new lenses (wider angles, shorter range). Furthermore, the rather expensive instrument will soon become much cheaper because of the market to detect heat leakage from structures and civil security application.

The wild life biologist may soon have large profits from this technological innovation.

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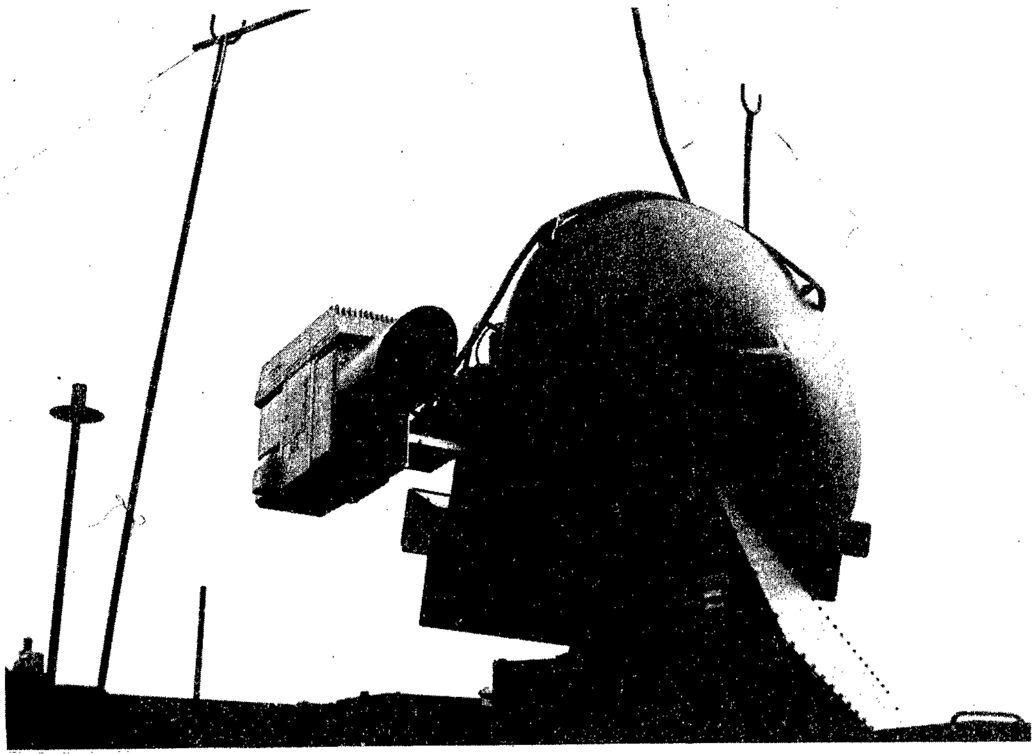


Figure 1

Figure 2

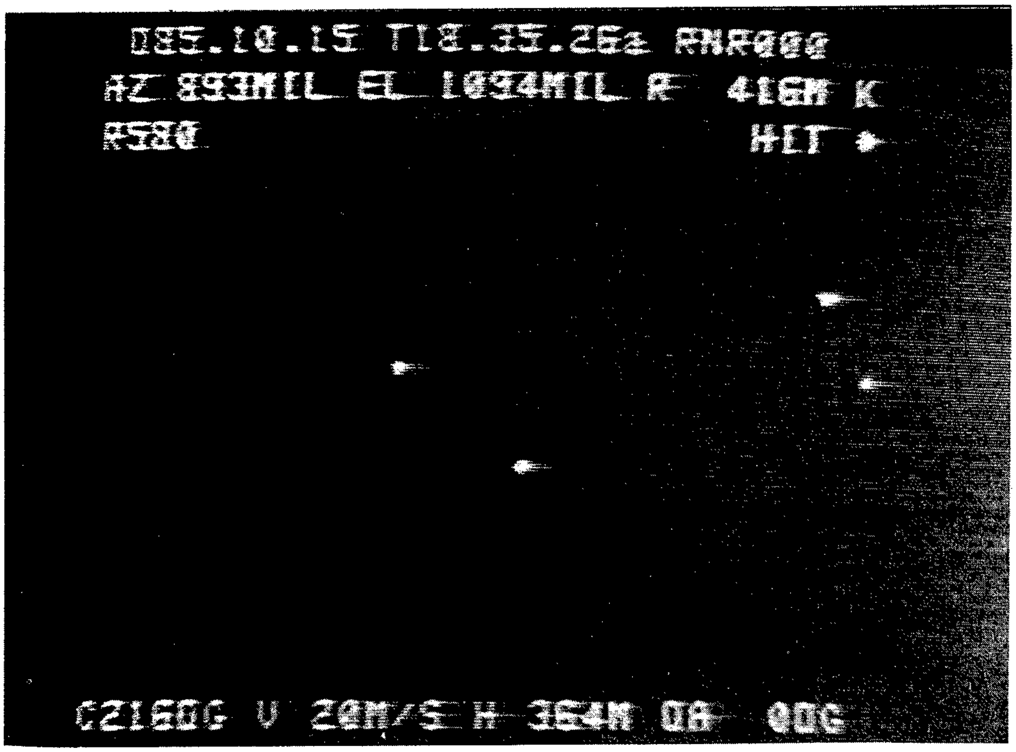
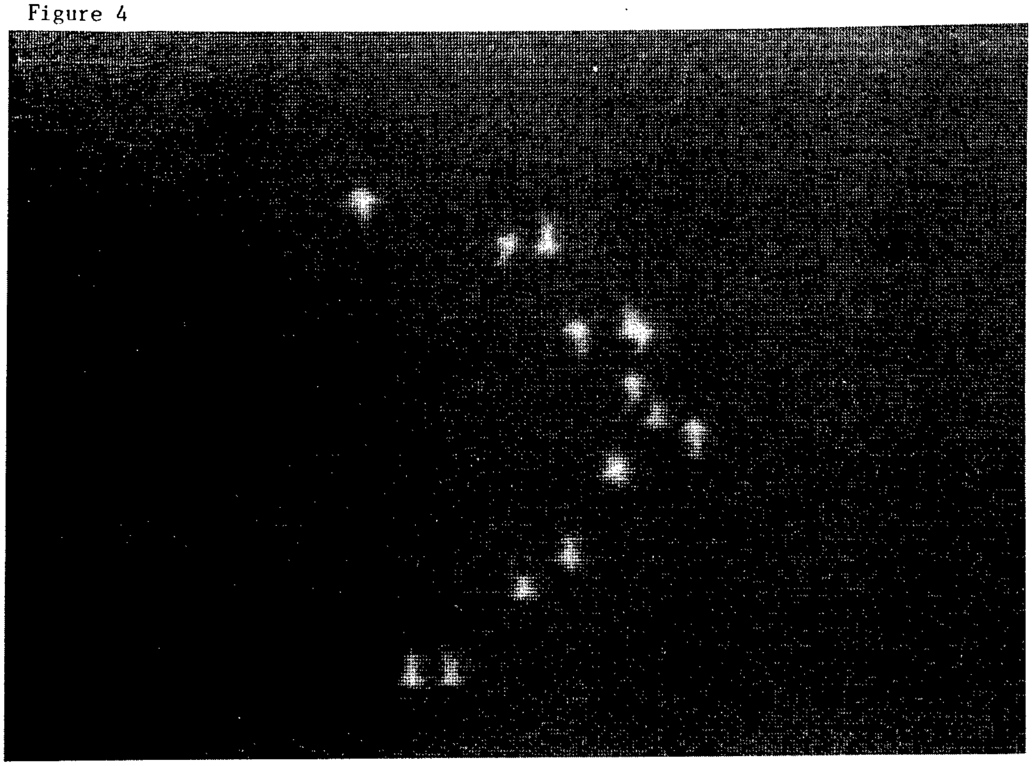
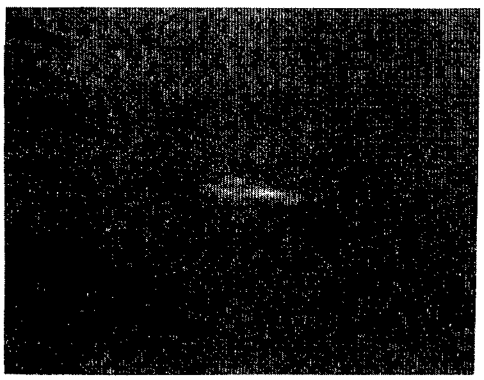


Figure 3

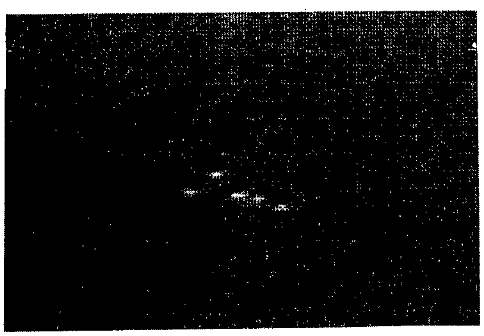
Figure 4



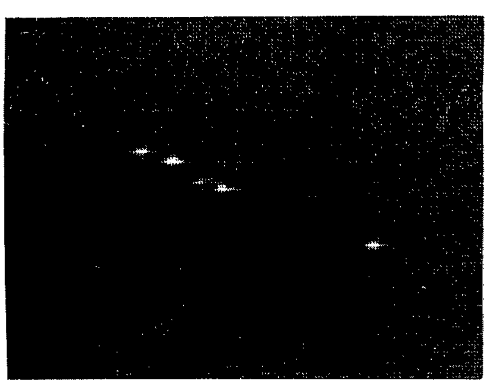
A: 1900 m



B: 1500 m

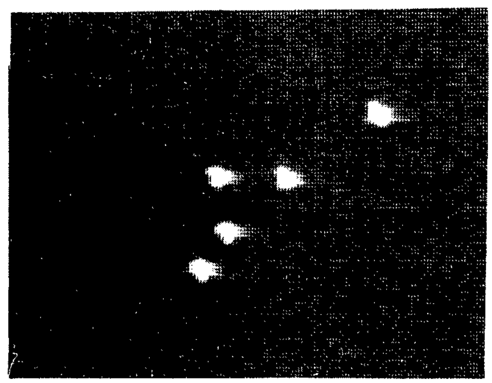


C: 1450 m

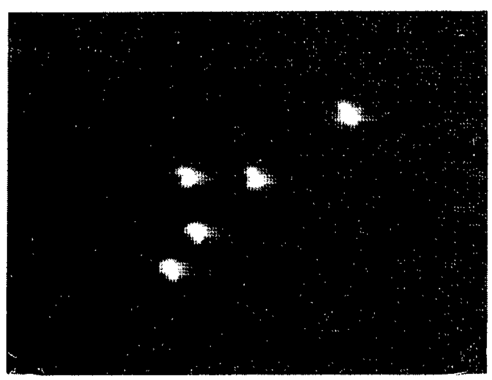


1300 m

E: 1200 m



F: 730 m



G: 730 m (side view)

Figure 5: flock of geese approaching the radar plus thermal camera (see text)

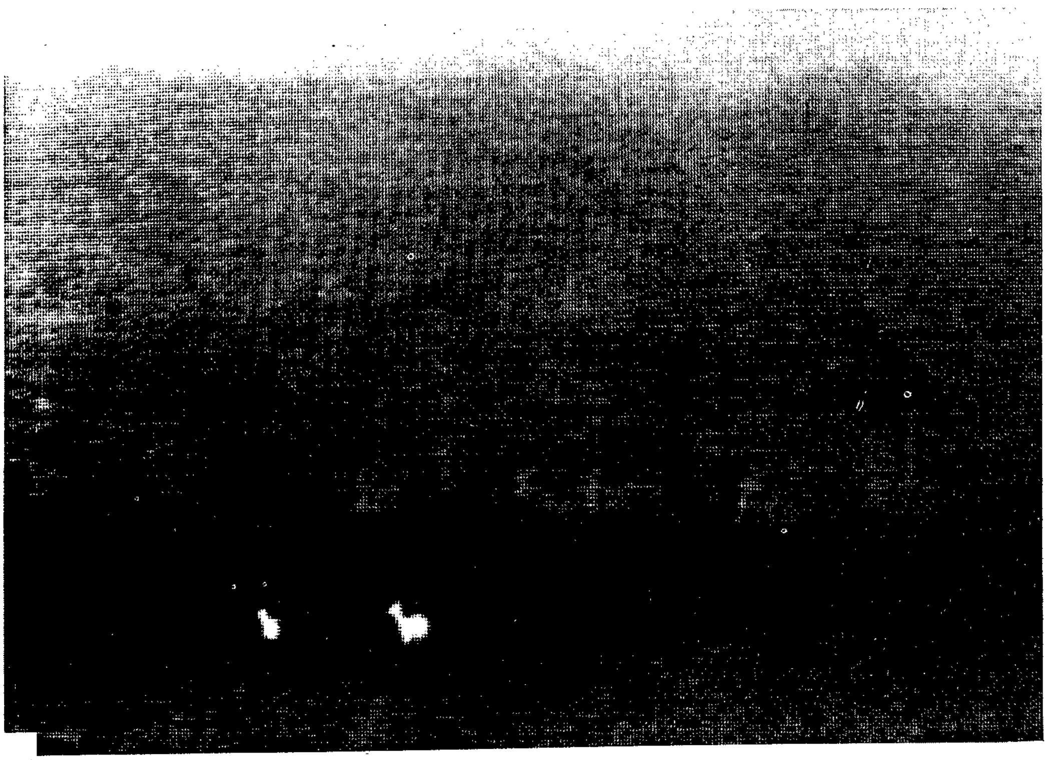
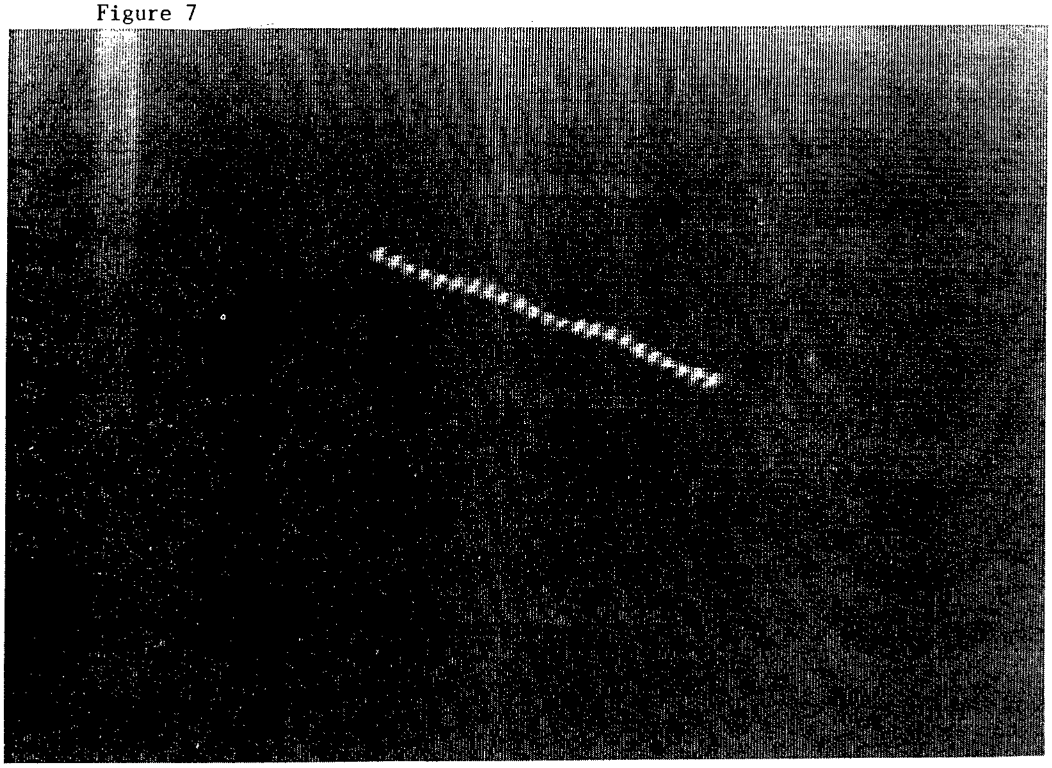


Figure 6

Figure 7



BSCE 19
Madrid, May 1988

REPORT OF THE CHAIRMAN

Monday, 23 May 1988

For the first time in the history of BSCE our Committee convenes in the capital of Spain. The preparations for this meeting was initiated 5 years ago, and it was finally during our 17th meeting 4 years ago in Rome that we were told that the Spanish authorities would be willing to act as host to this meeting.

It is the first time that I have had the experience to have to contribute to a meeting in a country outside my own country, but I can assure you that it has been a very easy job thanks to the spirit of cooperation I have always met when discussing with our Spanish hosts. I think that this spirit of cooperation bodes well for the meeting and further gives an indication of the interest which the Spanish authorities take in our work so that we also in future can be assured of a valuable Spanish contribution to our meetings.

Since our meeting in Copenhagen 2 years ago, the Steering Committee has met only once. It was last September in the Mosel Valley during the wine harvest. Apart from sampling many sorts of the Mosel wine with the good guidance of our old friend, Jochen Hild, we made preparations for this meeting and had discussions regarding the third edition of the booklet "Some Measures ...". I will return to that later on, and further we discussed the BSCE Index, the result of which you will find in the bound set as WP/3 and which I will present at our meeting on the 26.

Finally, we discussed some changes regarding the chairmanships and vice-chairmanships of our various working groups and we will, later, elect a new chairman and a new vice-chairman of the Bird Movement Working Group and a new vice-chairman of the Analysis Working Group. At the Plenary on Thursday we will elect the chairman and the vice-chairman of BSCE as a whole for the next period.

The changes from our previous way to structure the presentation of working papers have been maintained as you will see from the bound set which, I hope, you have all collected.

I am fairly satisfied that we this year have received 22 working papers covering 219 pages before the deadline compared with the 15 working papers covering 132 pages we received at our last meeting. But I shall still hope that we can improve this situation especially when I remember what our colleagues from the US accomplished during a meeting in Charleston some years ago.

I shall now turn to the outcome of the work performed in the various BSCE working groups:

The **Aerodrome Working Group** was left with only one recommendation from the Rome meeting. It deals with the EEC directive on the conservation of wild birds, especially Article 9, para. 3, and the Committee recommended to EEC member states to keep the Chairman and the liaison officer informed of the report sent to the EEC commission about the implementation of EEC directive 79/409 and to maintain contact with the Chairman and the liaison officer in case the EEC Commission will promote action in the field affected by the BSCE recommendations.

To my knowledge the relevant authorities are still doubtful as to the extent which the EEC Secretariat wishes to have reports. This question was raised some years ago, as far as I remember in Moscow, when the French delegation expressed their apprehension that the EEC measures to conserve wild birds could collide with our efforts to protect our aerodromes against the presence of birds. But till now I have heard of no such efforts and I have received no information.

The Aerodrome Working Group chairman has been busy collecting material for the 3rd edition of the booklet on measures to reduce bird risk around the airport. Such an addition has in fact been finalized and the chairman has brought with him some twenty copies of the booklet to this meeting.

The **Analysis Working Group** was left with 4 recommendations:

1. The first one was a reminder that details of strikes to their own countries' aircraft which occur <u>outside</u> their own country, should be sent to the <u>relevant</u> person in the country in which it occurred.

   Response:

   A list of names and addresses has now been provided to facilitate this task.

2. The second recommendation was that all members use the following criteria in defining whether a civil strike is on or near an airport;

	CLIMB	APPROACH
ON	0 to 500 ft	200 ft to 0
NEAR	501 to 1500 ft	1000 ft to 201 ft
EN ROUTE	1501 ft and above	1001 ft and above

Response:

This has now been implemented and all members provided their data according to this format.

3. The third recommendation was that maintenance personnel be reminded that whenever evidence is found of a birdstrike, this should be reported on the Birdstrike Reporting Form and any feathers or remains be sent to the appropriate person for analysis.

Response:

This is for individual countries to implement at their discretion.

4. The final recommendation was that BSCE Analysis for 1985 data incorporating ON, NEAR and DAMAGE be sent by 1st November 1986 to

- Working Group Chairman (J. Thorpe for civil analysis)
- Dr. J. Hild for military analysis

Details of any serious incidents to civil aircraft should be sent to the Working Group Chairman as soon as possible after the event.

Response:

All the 1985 data has been completed in the manner requested and a paper will be presented during this meeting in Madrid. The 1986 data is not yet complete but it is hoped that it will be available after the meeting with the proceedings of the meeting. Work is in hand on the limited amount of military data.

The serious events are contained in a paper being presented by the Working Group Chairman during the meeting.

Further activity:

a. After holding the position of Vice Chairman for a number of years Mr. R. Van Wessum from the Netherlands has had to resign owing to a change of post. Mr. Bertil Larsson from Sweden has agreed to replace him.

b. In October 1987 the Working Group Chairman attended the first Central and South American region ICAO workshop on bird hazards in Mexico City and presented a number of papers. There had been very little activity on bird hazards in these regions and apart from ICAO there was only two papers from any of the countries in the regions. Nine countries sent representatives, unfortunately Brazil was not among them.

c. The Working Group Chairman has produced a "Bird Avoidance" Leaflet in the UK General Aviation Safety Sense series. This is being presented at this meeting as part of the Communication and Flight Procedures Working Group.

The **Bird Movement/Low Level Working Group** was left with the following recommendations:

1. Maps on bird concentrations and migration methods should be revised.

2. Risk maps for airport facility areas should be drawn up.

In Germany the following new maps have been issued last year:

- AIP Germany, RAC 3-6-3 concerning bird concentrations and bird movements in the Federal Republic of Germany (1 May 1987)

- Catalogue/map concerning protected areas with higher birdstrike risk in the Federal Republic of Germany in "Vogel und Lufverkehr" (Bird and Air Traffic), the official periodical of the German Birdstrike Commmittee (August 1987).

The work concerning bird hazard at low level with the aim to develop preventive measures to minimize the bird hazard to low flying aircraft has started with two meetings, one in November 1986 and one in September 1987. The agenda for these meetings included the following topics:

- Progress in the observation of bird movements by radar

- Criteria to issue birdstrike warnings/BIRDTAMs

- Dissemination of birdstrike warnings/BIRDTAMs

- Actual status of flight procedures and restrictions on receipt of birdstrike warnings/BIRDTAMs

- Action to be taken according to bird hazard maps and birdstrike risk forecasts

- Action in the event of a birdstrike.

The Belgian, German, the Royal Netherlands Air Force, and the Canadian Royal Air Force and the United States Air Force in Germany, Europe, participated in the meeting. The reports of the meetings will be presented in a working paper at this meeting.

Regarding the **Working Group Communication and Flight Procedures**, you will recall that the group was left with the following two recommendations:

- To collect data encompassing methods used for transmission of bird hazard information and flight procedures suggested to reduce or avoid bird strikes to be published.
- To contemplate standardization of flight procedures for helicopters, light aircraft and military low-flying aircraft.

You will also recall that the working group chairman was not able to attend the Copenhagen meeting, and unfortunately we shall also miss his presence at this meeting. He has, however, by telephone informed me that he has not been able to do any work about these recommendations, but as some working papers are assigned to this working group, the working group meeting will be held as planned in WP/2 under the temporary chairmanship of Mr Kirjonen, Finland, whom I have persuaded to act as chairman during this meeting.

Next comes the **Radar Working Group** which during the Copenhagen meeting expressed the wish that the booklet "Use of Radar for Bird Strike Prevention" should be prepared for the next meeting of BSCE. This recommendation has been met in so far that during this conference a full draft of the booklet is avilable. Those of you who join the Radar Working Group can get a copy to study before the Radar Working Group convenes. Other who wish to receive the printed version to be produced some months after this BSCE meeting should contact the authors, L.S. Buurma and B. Bruderer.

One of the key items of the radar booklet and the Radar Working Group meeting is future developments with respect to electronic assessment of bird densities via radar. Reports on new experiences in the USA, Switzerland, Belgium and Holland will stimulate the discussion. This is urgently needed, especially for military aviation, because low-level training is suffering more and more from bird strikes. Quick and standardized bird measurements and predictions are the only solution to this problem. During the last two years members of the Radar Working Group and the Bird Movement Working Group closely cooperated. For military aviation the increase if the number of member states ratifying a Standard NATO Agreement on BIRDTAMs is an important development.

The biological aspect of the problem, mainly how to detect, quantify and interpret bird movements at lov level, is the second subject to be discussed by the Working Group. In this respect several limitations of the use of certain

radars became apparent only recently. Apart from the applications for flight safety, new ornithological insights may also be at stake. The group hope to stimulate new radar ornithological studies emphasizing on the quantitative aspects. Selection of new study areas is needed, not only to complete existing knowledge with new geographical aspects but also to generate fresh ideas. They are eager to receive news from eastblock countries. According to the last Working Group recommendation "Finland and the Soviet Union should continue to improve the mutual exchange of actual radar information on mass migration of waterfowl in areas of common interest."

This conference will indicate that knowledge about local bird movements represents an important missing link in our understanding and control of the bird problem around aerodromes. Radar and other remote sensing techniques can also play a role here, and therefore contribute to civil flight safety.

The **Structural Testing Working Group** was left with the following recommendations:

- Bird strike tests on Aramid Epoxy Composite Structures be done.
- Tests to study low-temperature effect on the resistance on various windshield glasses.
- Testing of NIDA and shock absorber materials' bird strike resistance.

I have been informed that the work of this group has run into some snags which has hampered immediate results, but the question as to extend the terms of reference to include study of engines will be taken up in the Working Group.

Regarding the relations between our Committee and other international organizations, I have already mentioned the EEC and the ECC Directive regarding bird conservation. Regarding ECAC we have at each meeting of the Technical Committee reported on our various activities, most recently during a meeting in March this year when the former BSCE vice-chairman, Elisabeth Dallo, on behalf of the Committee promised to present the modification in the Aerodrome Working Group booklet to ECAC. We certainly welcome the interest of ECAC, but we shall have to appoint a rapporteur to ECAC as we have been told that Vital Ferry will no longer be able to act as such. Regarding ICAO we are happy to see among us the acting chief of the Aerodromes, Air Routes and Ground Aids section, Mr. José L. Santamaria, from Montréal, and we know that the problem of bird hazard reduction was discussed during the 26th Session of the ICAO Assembly two years ago to the effect that the Assembly suggested that the Secretary General's follow up actions to increase efforts to combat bird strikes

should be coordinated, and that development of measures to combat bird strikes should be given high priority. We are also aware that the European bureau of ICAO has shown a great interest to receive the results of our work to take it into account in the foregoing revision of ICAO Doc 9137. Further, the chairman of the Analysis Working Group has continued to assist ICAO regarding the IBIS system.

As tne Chairman of BSCE I received an invitation to attend a ICAO workshop meeting in Mexico last September but was unable to come, and luckily our Committee was represented both by Jochen Hild and John Thorpe.

In the various ICAO papers I have received I have seen that there should be another workshop meeting this autumn in East Africa, but perhaps Mr. Santamaria when we arrive at the Plenary meeting Thursday will elaborate a little more on that topic.

As in future we have noticed with pleasure the interest IATA has shown towards our work and I welcome the presence of Capt. Sabando from the Spanish airline, IBERIA, at this meeting.

I would also like to inform you that the 20th meeting will be held in Finland in the spring of 1990, and preparations are going on to have the 21st meeting in Israel in the spring of 1992. If countries would like to act as host for further meetings, they are most welcome to contact me.

BSCE 19 Madrid,
23rd May 1988
Revised edition

ANALYSIS WORKING GROUP - CHAIRMAN'S PROGRESS REPORT

1. Recommendations from 18th Meeting, Copenhagen May 1986

a) The first was a reminder that details of strikes to their own countries aircraft which occur outside their own country, should be sent to the relevant person in the country in which it occurred.

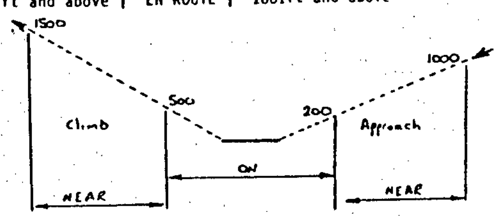
Response:

A list of names and addresses has now been provided to facilitate this task.

b) The second recommendation was that all members use the following criteria in defining whether a civil strike is on or near an airport,

strike is ON or NEAR an airport:-

CLIMB		APPROACH
0 to 500ft	ON	200ft to 0
501 to 1500	NEAR	1000ft to 201ft
1501ft and above	EN ROUTE	1001ft and above



Response :

This has now been implemented and all members provided their data to this format.

c) The third recommendation was that maintenance personnel be reminded that whenever evidence is found of a birdstrike, this should be reported on the Birdstrike Reporting Form and any feathers or remains be sent to the appropriate person for analysis.

Response:

This is for individual countries to implement at their discretion.

d) The final recommendation was that BSCE Analysis of 1985 data incorporating ON, NEAR and DAMAGE be sent by 1st November 1986 to

- Working Group Chairman (J. Thorpe for civil analysis)
- Dr J. Hild for military analysis

Details of any serious incidents to civil aircraft should be sent to the Working Group Chairman as soon as possible after the event.

Response:

All the 1985 data has been completed in the manner requested and a paper presented during the Madrid meeting. The 1986 data is not yet completed but it is hoped that it will be available after the meeting with the proceedings of the meeting. A paper containing the limited amount of military data was also presented at the Madrid meeting.

The Serious Events to Civil Aircraft are contained in a paper presented by the Working Group Chairman during the Madrid meeting.

2. Further Working Group Activity

a) After holding the position of Vice Chairman for a number of years Mr R. Van Wessum from the Netherlands has had to resign owing to a change of post. Major Bertil Larsson from Sweden agreed to replace him.

b) In October 1987 the Working Group Chairman attended the first Central and South American region ICAO workshop on bird hazards in Mexico City and presented a number of papers. There has been very little activity on bird hazards in these regions and apart from ICAO there were only two papers (Argentina and Trinidad & Tobago) from any of the countries in the regions. Nine countries sent representatives, unfortunately Brazil was not among them.

c) The Working Group Chairman has produced a "Bird Avoidance" leaflet in the UK General Aviation Safety Sense series. This is being presented at the Madrid meeting as part of the Communications and Flight Procedures Working Group.

3. Papers discussed at 19th Meeting, Madrid

a) The Working Group Chairman introduced Bird Hazards to Civil Aircraft on a series of colour slides of accidents and incidents.

b) "Analysis of Military Aircraft Bird Strikes 1985/6" was presented by Dr J. Becker, Germany (WP 5). There was considerable discussion on the use and continued collection of these data since few countries were providing information in the correct form. It was agreed that in future low level strikes would be separated out in order to assist the Low Level Sub-Group. The loss of a German Air Force F-104 in 1985 when flying over a hole in the ice-covered sea near Bornholm was described. Gulls were ingested, the pilot ejected safely. It was also agreed that an additional paper would in future be provided with a description of accidents and serious incidents to military aircraft, i.e. similar to civil aircraft paper. It was also agreed that considerable efforts would be put into obtaining better and more data from military participants.

c) Dr Bruderer introduced "Some proposals for Evaluation of Bird Strike Data" (WP 39). He showed that there was bias in the statistics and proposed that major airlines be requested to provide their movements and strikes at each airport in their route structure. This would highlight those airports with a high number of strikes and low number of movements in a consistent way. By collecting these data from a number of airlines reliable information could become available.

d) "How meaningful are Birdstrike Statistics" (WP 35) by Dr C. Thomas, UK, covered the different standards of reporting from pilots, engineers and airport staff. Considerable discussion resulted on whether:

- dead birds picked up at the airport should be included
- new misses should be included

or whether only pilot reports should be considered.

There was considerable variation from country to country in what was used for analysis and it was felt that with computer stored data it would be easy to choose. It was noted that it may be necessary to amend reporting forms to collect this information since the ICAO form did not specifically request the reporter's occupation.

e) "Bird Strikes During 1985 to European Registered Civil Aircraft" was presented by J. Thorpe, Uk (WP 20). Data from some countries was missing and it was requested that this must be provided by 30 June 1988 for inclusion in an analysis of five years of data from 1981 to 1985. This may be available in time for inclusion in the meeting report. 1985 had been a slight improvement on 1984 but 88 engines were damaged. Costs were estimated to be US $ 35 million for European airlines. There had not been any aircraft losses or injuries.

f) Mr A. Eudot, France, described the French data storage system using a micro-computer compatible with IBM PC (WP 29).

g) A paper describing the preliminary results from special markings on the spinner of large fan engines used in B-747SR and B-767 of All Nippon Airways was briefly described by the Working Group Chairman. The paper was obtained via ICAO and was tabled as WP 25. The data was inconclusive, but part of the data indicated the markings had a positive effect. Comparison of the data with other airlines was thought to be the next step. Although the data did not appear to have been statistically checked, participants may consider an approach to their airlines to undertake a similar trial.

h) "KLM Birdstrikes During 1987" (WP 37) by C. Bakker, Netherlands, described the record of the year. The data showed that there had been a small decrease in the strike rate compared with 1986.

i) "USAF Birdstrikes 1986/1987" (WP 27) by Capt. R.P. DeFusco, USA, was presented. They had suffered their two worst years with four aircraft lost and six fatalities, and costs of birdstrikes amounting to US $ 260 million. The aircraft lost were two F4's, an F16, and a B1B bomber. In a serious incident in December 1987 a B747 command post aircraft had collided with a flock of snow geese causing 30 holes.

j) Mr Santamaria, from ICAO Montreal, gave a resume of the current situation, data available, etc. and stressed the need to use the supplementary form on Damage and Cost, which was not often used. IATA were being approached to obtain better use. All were reminded that if they needed information, they should ask ICAO Montreal for it.

4. Recommendations

1) That military "low level" en-route strikes should be analysed separately by BSCE members. A separate set of forms will be necessary.

2) That details of military accidents and serious incidents should be sent by BSCE members to the German Geophysical Office (Dr Becker) for inclusion in a paper describing serious strikes to military aircraft.

3) BSCE members should urge that means be provided to enable civil data to be analysed by reporter's occupation. Members who already have this information should urge the appropriate authorities to provide it to ICAO.

4) That the civil BSCE members should ask their major airlines for their movement data at airports in their system. These data would be combined with strike reports from airports and be passed to the Working Group Chairman so as to indicate those airports where a bird strike problem exists.

5) BSCE analyses should be sent by BSCE members as follows:

- Civil Data to Working Group Chairman
  for 1985 by 30 June 1988
  for 1986 by 30 June 1988
  for 1987 by 30 November 1988

- Military Data to Dr Becker
  for 1987 by 30 November 1988
  for 1988 by 30 November 1989

John Thorpe
Analysis Working
Group Chairman

BSCE 19 Madrid,
May 1988
Revised version

AERODROME WORKING GROUP - CHAIRMAN'S REPORT

1. Agenda

The following was proposed and approved:

a) Approval of the agenda
b) Chairman's report on progress since previous meeting
c) Presentation of "The green booklet"
d) Presentation of working papers
e) Recommendations
f) Other business

2. The green booklet

The 3rd edition of the green booklet was available at the meeting. It was presented by Mr. O. Stenman. It was suggested by Mr. Stenman that a fourth edition should be prepared for the next BSCE meeting.

3. Working papers presented

WP 8 & 13:	Radio-controlled bird defense system STEFFAN. (H. Hauff and H. Fürbeth - FRG)
WP 17:	Birds at Copenhagen Airport Kastrup. (A.M. Glennung - Denmark)
WP 10:	The development of an effective bird detection and dispersal programme (C. Thomas - UK)
WP 33:	The use of synthetic noise generators on French airports (J.L. Briot - France)
WP 21:	Evaluation of bird population at Spanish airport: outline and results. (P. Morera - Spain)
WP 31:	Advantages and limitations of radio-controlled aircraft in bird dispersal (A.E. Bivings - USA)
WP 30:	Bird strikes at Israel Ben-Gurion Airport 1982-1986 (S. Suaretz, I. Agat, E. Shy - Israel)
WP 12:	Characterization of the birdstrike hazards to the space shuttle orbiter (J.J. Short - USA)
WP 26:	Overview of bird control in U.K. (T. Brough - UK)

Mr. Bruderer presented some preliminary information about "Altered ground cover and bird presence at Zurich Airport". This paper will not be published in the minutes of this meeting.

Mr. Ferrari (Italy) presented at video-film on the experiment of "ultrasonic noise for bird dispersal".

Due to lack of time during the meeting two working papers have not been presented.

WP 28: Visual lapwing counts versus aircraft-lapwing strikes (A. Dekker & L. Buurma - Netherland)

WP 42: Means and methods of bird number reduction within the airport area (USSR)

Working paper 28 will be presented at the plenary meeting.

4. Recommendations

The working group proposes the following recommendations:

4.1 That BSCE members be reminded that new methods of scaring birds should be tested scientifically and not subjectively.

4.2 BSCE members should send their contribution for the next edition of the green booklet to the chairman of the aerodrome working group not later than the 30th June 1989.

BSCE 19 Madrid,
May 1988
Revised version

RADAR WORKING GROUP - CHAIRMAN'S REPORT

1. TITLE

Radar and other sensors

2. TERMS OF REFERENCE

Matters associated with the use of radar and other sensors in the surveillance, the identification and the assessment of bird presence and movements.

3. PROGRESS REPORT

3.1 work done since last meeting

In line with the Copenhagen recommendation about the mutual exchange of information on mass migration in areas of common interest, Finland and Estonia intensified radar and visual observations. They informed each other about the starts of peak passages of arctic migrants. A meeting concerning these matters took place in Tallin.

According to the second recommendation of the Copenhagen meeting, a first draft of the proposed booklet on " The Application of Radar for Bird Strike Reduction" was discussed among a few members of the Working Group. A second draft was prepared for the present meeting.

Discussions on the need of calibration of different radars used for bird warnings took place twice in Traben-Trarbach during the Low-Level Sub-Group. Information was exchanged about technical and operational aspects of electronic counting systems. The need for standardization was supported by further ratification of a Standard Nato Agreement on the international coordination of bird migration messages (Birdtams). The Netherlands, acting as custodian, delivered the background information, also on behalf of BSCE.

Research on migration in the areas of the North Sea and the Alps continued with special emphasis on altitudinal distribution and the influence of environmental conditions. Cooperation with visual observers demonstrated the high importance of migration at extremely low levels (below radar coverage) in the lowlands of Holland and Northern Germany.

3.2 Work done during the meeting

The following papers nicely combined the technical and biological aspects of radar ornithology, going from large to small scale:

a) R.P Larkin illustrated the fascinating capacities of pulsed doppler weather radars for bird detection in combination with modern computer technology. Dedicated software is presently in preparation for the Next Generation Weather Radars (NEXRAD) for the USA.

b) L.S. Buurma showed a series of slides explaining the echo pattern analysis within the new Dutch bird extractor ROBIN, becoming operational this year.

c) The small scale observations by tracking radar in Switzerland (B. Bruderer) have now reached a stage where bird tracks and bird numbers can be directly fed to a personal computer.

The second sequence of papers switched to more biological (field) work:

d) B. Larsson told about Swedish expeditions to Greenland where field observers and a big radar station revealed spectacular flights across the inland ice towards WNW and ESE.

e) B. Bruderer reported on radar observations at six sites in southern Germany and Switzerland.
Radar constant headings resulted in southward deviating tracks under the influence of the frequent westerly winds in southern Germany, while in the Swiss lowlands the birds flew WSW.

f) Nocturnal observation of migrating birds up to two kilometers by means of a new technology, thermal imaging, demonstrated surprisingly new possibilities for wildlife studies. This heat camera was used by L.S. Buurma in combination with a tracking radar.

Report from other contries

g) Germany reported the continued use of polaroid photos. A video tape nicely illustrated the additional filming system on some airport radars.

h) The BOSS system in Belgium is still working as reported in Copenhagen enlarging their reference data set.

i) USA: after a serious multiple bird strike with a Galaxy at Dover Air Force Base the USAF evaluated several radar types in order to monitor permanently bird movements. A GNP 20 fan beam radar was selected.

j) Denmark: the FAUST system is still in operation at three radar stations.

k) Norway continued to use polaroid photos at three ATC radars.

l) Finland: Visual and radar observation has been used operationally in cooperation with Estonia.

m) Israel: Realtime warnings to pilots are given on the basis of radar data from Ben Gurion airport. Altitudes and routes of soaring birds are studied by means of a motor glider.

Special discussion on a dedicated bird radar

A number of specialized working group members formulated design criteria for a small pencilbeam radar (side view range for a gull (G 100 cm^2): 10 km) fully dedicated to bird detection and quantification in three dimensions. The need for such an automatically operating instrument has been stated already in the early seventies, but ideas were divergent. Now, the agreement is surprisingly full. The bird radar should serve, in the first place, at locations with a clear bird problem such as certain airports and shooting ranges. Combined into networks they also could monitor large scale bird migration. Finally, they can help to calibrate the bird countring systems at existing larger radars. The booklet "The application of radar for bird strike reduction" will contain a chapter on this important agreement.

4. RECOMMENDATIONS

a) The BSCE members should urge that international cooperation with respect to further development of electronic assessment of bird hazards by radar be intensified.

b) When quantifying bird movements, the BSCE members should urge the appropriate authority to put emphasis on the proper inclusion of bird numbers at low level.

c) BSCE members should approach the industry to develop, commercially, a small bird radar according to BSCE specifications being drafted for inclusion in the radar booklet.

Luit S. Buurma & Bruno Bruderer

BSCE 19 Madrid,
May 1988
Revised version

BIRD MOVEMENT LOW LEVEL WORKING GROUP - CHAIRMAN'S REPORT

1. Title

Bird Movement Low Level Working Group

2. Terms og Reference

Study of bird concentration and movements, drawing up of special bird hazard maps for informal and planning purposes, and develop preventive measures to minimize the bird hazard to low flying aircraft.

3. Progress report

a) The working Group elected Dr. J. Becker, GMCO, as new chairman and Mr. A. Dekker, RNLAF, as new vice-chairman.

b) Some countries, e.g. France, Germany, and Greece, had revised the bird concentration maps for their national AIP, others will issue a new map collection within the next 4 years.

c) Two other types of maps are existing in several countries:
Maps concerning bird sanctuaries, wildlife reserves or other protected areas of ornithological importance as well wetland areas of international importance.
Maps concerning bird concentrations and movements in the airport vicinity according to special guidelines.
Other countries are planning such maps, and will decide in own responsibility whether there is a need of such maps.

d) A survey of the existing procedures for military low level flights was given during two meetings "Bird Hazard at Low Level" in 1986 and 1987. The participants emphazised the necessity of regular radar observations, standardized birdstrike warnings (BIRDTAM) as well as standing procedures for the flying units.

4. Future programme

a) Periodically updating of bird hazard maps for the national AIP according to Annex 15 of the ICAO Aeronautical Information Services, and with regard to recent knowledge of bird concentration areas and bird movements.

b) Local bird movements and bird concentrations in the vicinity of international airports, should be published in airports vicinity maps as part of the national AIP.

c) Issuing maps of protected areas and other areas of ornithological importance with the purpose of bird hazard prevention and bird protection.

d) Exchange of actual data concerning medium and high intensities of bird migration as well as birdstrike warnings (BIRDTAM) in a standardized format via the civil and military ATC or WX-networks.

5. Recommendations

a) BSCE members are requested to urge the appropriate authorities to revise existing national maps according to Annex 15 og the ICAO Aeronautical Information Service. Members of the BSCE working group are urged to send copies of the maps to the chairman of the working group.

Deadline: 1st January 1990

b) BSCE members are urged to ask the appropriate authorities to work up recent information concerning bird sanctuaries, and areas of ornithological importance for drawing up a corresponding European map, but the appropriate authority should decide its own responsability whether there is need for publication of such maps.

Deadline: 1st January 1990

c) BSCE members are urged to ask the appropriate authorities to draw up airport vicinity maps according to ICAO Annex 15, in close cooperation with airport authorities. BSCE members should send copies of such maps to the chairman of the working group.

Deadline: 1st January 1990

d) BSCE members are urged to ask the appropriate authority to improve the procedures of birdstrike prevention for aircraft flying at low level on the basis of standardized radar observations and exchange birdstrike warnings (BIRDTAM) concerning largescale bird movements in a standardized format via the ATC or WX-networks.

BSCE 19 Madrid,
May 1988
Revised version

COMMUNICATIONS AND FLIGHT PROCEDURES WORKING GROUP - CHAIRMAN'S REPORT

TERMS OF REFERENCE

Study of all problems relating to the transmission of information on bird movements which could present a hazard to aviation and the provision of such information to air traffic services.

AGENDA

1. Approval of Agenda
2. Appointment of Vice Chairman
3. Brief Introduction of Participants
4. Chairman's Report on Progress since Previous Meeting
5. Radar and Visual Observations of Sea Duck's Mass Spring Migrations in West Estonia and the Transmission of Birdtam from Tallin Airport to Helsinki-Vantaa Airport (WP 18). V.E. Yacobi (USSR).
6. Bird Avoidance (WP 19). John Thorpe (UK).
7. Other Business
8. Recommendations

1\. AGENDA WAS APPROVED

2\. Capt. Sonnette was elected as a vice-chairman of the meeting

4\. The Chairman went through the recommendations from BSCE 18. The working group noticed that there has been no progress on the previous recommendations. (BSCE 16 and 17).

5\. Olavi Stenman from Finnish Delegation gave a short report of the co-operation between Tallin Airport and Helsinki-Vantaa Airport of bird migration information. This is a good example of good development in Aerodrome Working Group.

6\. John Thorpe presented his working paper WP 19 "Bird Avoidance for General Aviation" which resulted in recommendation 3.

The group agreed that the contents was meant only for General Aviation. There was also some discussion concerning commercial aviation (recommendation 4.).

7\. Questions were raised about the effect of strobe lights on birds. No studies have been made yet, exept an US analysis by S. Gauthreaux (not yet published) with the conclusion that the strobe lights have no effect; it did not attract or repel birds. The conclusion has to be confirmed by future studies.

8. Recommendations:

1. That work be continued by the BSCE Working Group to review ICAO Annex 15's specifications concerning information on bird hazards.

2. That BSCE members are urged to ask the appropriate authorities that bird hazard warnings, e.g. NOTAM or ATIS, only be issued for significant hazards and for a short time.

3. That BSCE members should pass WP/19 "Bird Avoidance for General Aviation Pilot" to appropriate authorities in their country for possible inclusion in their documentation for general aviation pilots.

4. That BSCE members should urge the appropriate authorities in each country to take steps to inform their pilots, air traffic controllers, and airport authorities that birds are hazard to aircraft, e.g. by lectures, posters, leaflets, video, etc.

List of Participants

BELGIUM:
Gilbert Dupont

FRG:

D.J. Becker

FINLAND:

Seppo Kirjonen (Acting Chairman)
Reijo Lamberg
Olavi Stenman

FRANCE:

Jean-Claude Sonnette (Vice-Chairman)

ITALY:

Augusto Rossi
Salvatore Visconti

SPAIN:

Elvira Abajo
Juan A. Plaza

SWEDEN:

Bertil Larsson

UK:

John Thorpe

USA:

Major Ron Merritt

IATA:

Salvador Escriva

BSCE 19 Madrid,
May 1988
Revised edition

WORKING GROUP "STRUCTURAL TESTING OF AIR FRAMES"

Report of the 24 May 1988 Meeting

1. PRESENTATION OF WORKING PAPERS

WP/9 - Improving birdstrike resistance of aircraft wind shields.
By Ralph Speelman. Air Force Wright Aeronautical Laboratories, USA.

As at previous BSCE meetings Ralph Speelman presented the ongoing efforts to improve the windshield system bird strike resistance of aircraft assigned to high speed and low altitude missions.

Over 3000 bird strikes per year occur for USAF and during the past 18 years 13 aircrew members have been killed and 21 aircraft have been destroyed due to bird impact.

New polycarbonate windshields have been developed for F4 - A7 - F16 -T38 with studies of composite and magnesium frames, and moulded transparencies.

The flight dynamics Laboratory has also developed a 0,5 M $ device to carry out fatigue tests with cold and hot effects on the windshields.

WP/31 - Engine bird strike tests at CEPR SACLAY.
By J.P. Devaux. DGA/DCAe/CEPR Saclay (France).

CEPR Saclay, French Ministry of Defense, official engine test center presented the improvements which it has recently achieved in the test methods to avoid test installation failures.

In particular Mr. Devaux presented results from studies on projectile type (test now uses gulls instead of chickens for 1,5 and 4 lb bird official tests) and multiple impacts avoidance (several birds striking the same blade).

- Some tests including the new test methods were shown on TV video.

The encouraging results encountered by the high level test technology developed by CEPR is now being used for propeller FOD+ tests.
(+ Foreign Object Damages).

2. OTHER ITEMS

- The group decided to increase its activity field by including the engine testing
- New title proposed for the Working Group:
"Testing of Airframes and Engines."

3. <u>ACTIVITY OF THE GROUP BETWEEN BSCE MEETINGS</u>

As indicated in previous recommendations, it is important to promote the work of the group by giving the names and addresses of specialists from the different countries to the Working Group Chairman (for frames and engines).

The French members of the group will study the opportunity to organize a meeting in Paris during spring 1989 for testing airframes engine specialists.

The Vice-Chairman of the group:
R. Peresempio (Italy) will again be able to act in the group next month.

4. <u>RECOMMENDATIONS OF THE GROUP</u>

BSCE members should seek information on the retention of birdstrike capability after extended in service usage of engines and airframes.

BSCE 19 Madrid,
May 1988

REPORT ON THE MEETING OF THE SUB-GROUP ON FEATHER IDENTIFICATION

Rapporteur: Tim G. Brom

During the BSCE meeting in Rome in 1984 it was decided to form a sub-group on Feather Identification within the Analysis Working Group.

Here in Madrid, this sub-group came together for the second time. After some confusion and re-scheduling there was a working lunch with 13 participants from seven countries. Working paper 24 was discussed, entitled "The Analysis of Feather Remains: Evaluation and Perspectives," and more general information was exchanged between the participants.

A questionnaire was compiled in order to make an inventory of the persons working in this field and of the methods they employ.

The participants reached the following conclusions:

1) proper identification of bird remains is essential and fundamental to bird strike statistics,

2) within BSCE there is a growing interest in the methods of identification and the wish was expressed to establish contacts between people working in this field.

Based on these conclusions, the participants in the meeting of this sub-group would like to put forward two suggestions to this meeting and to the Steering Committee:

1) that this group be raised to Working Group level, in which case the name probably better be changed from Feather Identification to Bird Remains Identification Working Group,

2) that the meeting of this Working Group or Sub-group will have a place of its own on the agenda of BSCE 20 in Helsinki before the start of that meeting.

BCSE 19
Madrid, May 1988

RECOMMENDATIONS

AERODROME WORKING GROUP

1. BSCE members be reminded that new methods of scaring birds should be tested scientifically and not subjectively.
2. BSCE members should send their contribution for the next edition of the green booklet to the chairman of the aerodrome working group not later than the 30th June 1989.

ANALYSIS WORKING GROUP - CHAIRMAN'S PROGRESS REPORT

1. That military "low level" en-route strikes should be analysed separately by BSCE members. A separate set of forms will be necessary.
2. That details of military accidents and serious incidents should be sent by BSCE members to the German Geophysical Office (Dr Becker) for inclusion in a paper describing serious strikes to military aircraft.
3. BSCE members should urge that means be provided to enable civil data to be analysed by reporter's occupation. Members who already have this information should urge the appropriate autnorities to provide it to ICAO.
4. That the civil BSCE members should ask their major airlines for their movement data at airports and be passed to the Working Group Chairman so as to indicate those airports where a bird strike problem exists.
5. BSCE analyses should be sent by BSCE members as follows:
   - Civil Data to Working Group Chairman
     for 1985 by 30 June 1988
     for 1986 by 30 June 1988
     for 1987 by 30 November 1988
   - Military Data to Dr Becker
     for 1987 by 30 November 1988
     for 1988 by 30 November 1989

BIRD MOVEMENT LOW LEVEL WORKING GROUP - CHAIRMAN'S REPORT

1. BSCE members are requested to urge the appropriate authorities to revise existing national maps according to Annex 15 of the ICAO Aeronautical Information Service. Members of the BSCE working group are urged to send copies of the maps to the chairman of the working group.

   Deadline: 1st January 1990

2. BSCE members are urged to ask the appropriate authorities to work up recent information concerning bird sanctuaries, and areas of ornithological importance for drawing up a corresponding European map, but the appropriate authority should decide its own responsability whether there is need for publication of such maps.

   Deadline: 1st January 1990

3. BSCE members are urged to ask the appropriate authorities to draw up airport vicinity maps according to ICAO Annex 15, in close cooperatin with airport authorities. BSCE members should send copies of such maps to the chairman of the working group.

   Deadline: 1st January 1990

4. BSCE members are urged to ask the appropriate authority to improve the procedures of birdstrike prevention for aircraft flying at low level on the basis of standardized radar observations and exchange birdstrike warnings (BIRDTAM) concerning largescale bird movements in a standardized format via the ATC or WX-networks.

COMMUNICATIONS AND FLIGHT PROCEDURES WORKING GROUP - CHAIRMAN'S REPORT

1. That work be continued by the BSCE Working Group to review ICAO Annex 15's specifications concerning information on bird hazards.

2. That BSCE members are urged to ask the appropriate authorities that bird hazard warnings, e.g. NOTAM or ATIS, only be issued for significant hazards and for a short time.

3. That BSCE members should pass WP/19 "Bird Avoidance for General Aviation Pilot" to appropriate authorities in their country for possible inclusion in their documentation for general aviation pilots.

4. That BSCE members should urge the appropriate authorities in each country to take steps to inform their pilots, air traffic controllers, and airport authorities that birds are hazard to aircraft, e.g. by lectures, posters, leaflets, video, etc.

RADAR WORKING GROUP

1. The BSCE members should urge that international cooperation with respect to further development of electronic assessment of bird hazards by radar be intensified.

2. When quantifying bird movements, the BSCE members should urge the appropriate authority to put emphasis on the proper inclusion of bird numbers at low level.

3. BSCE members should approach the industry to develop, commmercially, a small bird radar according to BSCE specifications being drafted for inclusion in the radar booklet.

WORKING GROUP "STRUCTURAL TESTING OF AIR FRAMES"

BSCE members should seek information on the retention of birdstrike capability after extended in service usage of engines and airframes.

MINUTES OF THE PLENARY MEETINGS 26-27 MAY 1988

1. OPENING BY THE CHAIRMAN

The meeting was opened by the Chairman.

2. WORKING GROUP COMMUNICATION AND FLIGHT PROCEDURES

The Vice-Chairman of the working group "Communications and Flight Procedures", J.C. Sonnette, France, presented the report from the working group paying tribute to Mr. Seppo Kirjonen, who with a very short notice agreed to act as chairman for the working group.

To a question from Bakker, the Netherlands, regarding the effect of landing lights, J.C. Sonnette informed the meeting that the problem had been discussed and that the conclusion was that in most cases landing lights did have a positive effect but there are some problems with the landing lights during night.

Whereas A. Ferrari, Italy, indicated that both landing lights and strobe lights were not particularly useful in order to scare the birds, J. Thorpe, UK, indicated that because of the problem with the crowded skies throughout the world all pilots would wish to use landing lights in the aerodrome area and strobe lights as well so that other aircraft and the air traffic controllers could see them and therefore there was no need within BSCE to prolong this discussion.

Bruderer, Switzerland, added that to him as a biologist it was clear that if an aircraft is made visible at an earlier stage to a bird, avoidance would be easier for the bird. On the other hand it was also a well known fact that in foggy situations you can trap birds with lights because they fly towards the lights. That goes for the landing lights but not for the strobe lights which are not steady lights and consequently do not attract birds. He added that some trials concerning strobe lights are going on in Swissair.

After some discussions, particularly as to who should make the recommendations and to whom the recommendations should be made, the recommendations mentioned below were adopted by the meeting:

1. That work be continued by the BSCE working group to review ICAO Annex 15's specifications concerning information on bird hazards.

2. That BSCE members are urged to ask the appropriate authorities that bird hazard warnings, e.g. NOTAM or ATIS, only be issued for significant hazards and for a short time.

3. That BSCE members should pass wp/18, "Bird Avoidance for General Aviation Pilot", to appropriate authorities in their country for possible inclusion in their documentation for general aviation pilots.

4. That BSCE members should urge the appropriate authorities in each country to take steps to inform their pilots, air traffic controllers, and airport authorities, that birds are hazards to aircraft, e.g. by lectures, posters, leaflets, video, etc.

3. WP/7 "SPANISH BIRDS AND THEIR INFLUENCE ON FLIGHT AND MISSION PLANNING

C. Ros, Spain, presented wp/7, "Spanish Birds and their Influence on Flight and Mission Planning" and paid tribute to the co-author, Maria Jésus Mingarro, who had just given birth to her baby and was at home. Some one hundred slides were shown and C. Ros particularly mentioned the use of falconry near airport runways.

4. WP/15 "FUNDAMENTAL EXPERIENCES AND SUGGESTIONS FOR BIOTOPE-MANAGEMENT-PROCEDURES ON INTERNATIONAL AIRPORTS"

J. Hild, FRG, presented wp/15, "Fundamental Experiences and Suggestions for Biotope-Management-Procedures on International Airports".

5. WP/22 "SERIOUS BIRDSTRIKES TO CIVIL AIRCRAFT 1985 TO 1987"

J. Thorpe, UK, presented wp/22, "Serious Birdstrikes to Civil Aircraft 1985 to 1987".

To a question from Santamaria, ICAO, as to the use of the wording "serious birdstrikes" instead of "significant birdstrikes" J. Thorpe indicated that the list only contained the worst cases from the list of significant strikes.

Caithness, New Zealand, deplored that there was not enough information as to the costs of the bird strikes, to which J. Thorpe agreed adding that it was nearly impossible to find out the true costs. His estimates for the BSCE reports, e.g. European airlines, reported to him would show that the European costs due to bird strikes in one year were 35 million US $.

6. WP/39 "ROBIN, THE NEW BIRD EXTRACTOR ON RNLAF LONG RANGE SURVEILLANCE RADAR"

L.S. Buurma, the Netherlands, presented wp/39, "Robin, the New Bird Extrator on RNLAF Long Range Surveillance Radar". He referred to the discussion in the Radar Working Group and indicated that there was a need to put up criteria for special bird radar adding that it should be recognized that medium and even small birds flying rather low can be a hazard to aviation, especially to military aviation.

7. WP/21 "PRESENT STATE OF BIRD STRIKE HAZARDS AT SPANISH AIRPORTS"

J. Ruiz, Spain, presented wp/21, "Present State of Bird Strike Hazards at Spanish Airports". A video tape was also shown.

8. WP/31 "BIRD STRIKES PREVENTION IS BETTER THAN LEGAL LIABILITY"

T. Scorer, UK, presented wp/31, "Bird Strikes Prevention is Better than Legal Liability", and indicated that the failure to exercise proper care in bird control at an airport environment will render the operator liable under civil law to make compensation to those who suffer loss as a result of their failure. In the context of bird control it could be said that not only is it desirable from a safety point of view to have a safe environment for aircraft to operate but also if civil liability is to be avoided it is very important that the airfield operator adopts proper procedures and can show that he has exercised those procedures before the time an aircraft takes off if it later suffers a bird strike. A failure to exercise that proper care will expose the airport operator in most countries to liability and such a claim can have serious financial consequences to the airport operator and his insurers.

To a question from J. Thorpe T. Scorer answered that in law there is no difference between a flock of hazardous birds and a vehicle on the runway in terms of the airport's liability.

To a question from Bruderer who questioned the idea that the airport would have to prove that it is not guilty contrary to Roman Law according to which it is always the burden of the plaintive to prove that someone is guilty and has been negligent T. Scorer explained that when a process of litigation starts there is an obligation on both parties to produce for the court later at the hearing all the documents which they

have in connection with their defence and all the documents for the claimant to prove his claim. The important thing for the defendant i.e. the airport is to be prepared for the time when you are accused of being liable because of some alleged negligence.

J. Seubert, USA, envisaged problems in cases where because of the insurance the airport authority and the airport authority employees have no personal problem when a bird strike occurs because they were negligent.

T. Scorer maintained that first of all it is the responsability that airport authorities take reasonable steps and ensure that their employees are taking reasonable steps. If such steps are not taken the airport operator can exercise a personal sanction. As far as the airport itself is concerned in many cases airport authorities agree that they will take for themselves the first so many dollars, etc, of any liability and only the balance above will be down to the ensurer. Consequently it is a direct financial penalty to airport authorities, and here lies the incentive to ensure that the bird strike job is done properly.

To a question from P. Vuillermet, France, T. Scorer answered that the result of the bird strike efforts will give good indications of how effective your work is done. You find two airports with a simular bird strike problem and you can relate the two losses of the airports due to bird strikes. It was recognized that the amount which an airport will spend on bird strike prevention measures must be related to its income and to the probability of a bird strike hazard.

9. SWEDISH VIDEO

B. Martinsson, Sweden, showed a video indicating the work being done in Sweden just now.

P. Bentz, Norway, added that the experiments showed that trays with hawkeyes repelled birds simular to the work done in Japan. In Norway balloons with painted hawkeyes have been ordered from Japan and the Norwegian authorities intend to try them in the approach path where thousands of gulls frequently are soaring. Such balloons are very cheap and are frequently used in garden in order to repel birds so they do not eat apples, etc. P. Bentz promised to report on the trials at the next meeting.

B. Larsson, Sweden, asked if trials in order to get rid of the worms in the airport areas had been made elsewhere and added that as part of an experiment electric wires have been installed in different depths along the runway to prevent the worms from entering it

P. Bentz added that snails are an attraction to birds in Norway and asked if snails also constituted a problem elsewhere.

10. WP/42 "SELF-CONTAINED PORTABLE LASER TRANSMITTER"

J.D. Soudaze-Soudat, France, presented wp/42, "Self-Contained Portable Laser Transmitter" and added that electricity was supplied by portable battery supplies. The cost of the transmitter should be 6300 US $ per item. J.D. Soudaze-Soudat promised that the results of the trials which are going on will be published later by the French administration.

11. WP/27 "VISUAL LAPWING COUNTS VERSUS AIRCRAFT-LAPWING STRIKES"

A. Dekker, the Netherlands, presented wp/27, "Visual Lapwing Counts Versus Aircraft-Lapwing Strikes".

To a question from T. Jørgensen, Denmark, A. Dekker explained that he hoped that the reduction of the number of lapwing strikes from 3.5 to 1.0 would be a continous tendency as it had been from 1985 and onwards.

12. WP/3 "REVISED INDEX FOR BSCE WORKING PAPERS ISSUED DURING THE PERIOD 1966-1988 INCLUDING PAPERS PRESENTED AT THE 1977 WORLD CONFERENCE IN PARIS WHICH WAS ORGANIZED PARTLY BY BSCE"

H. Dahl, Denmark, presented wp/3, "Revised Index for BSCE Working Papers Issued during the Period 1966-1988 Including Papers Presented at the 1977 World Conference in Paris Which Was Organized Partly by BSCE".

It was agreed that the index paper should be updated after each conference and H. Dahl indicated that wp/3 in the final report would include all the papers presented at BSCE 19th.

13. BIRD MOVEMENT LOW lEVEL WORKING GROUP

The Chairman's report on the activities of the working group was presented by the new chairman, J. Becker, FRG.

After some discussions the recommendations mentioned below were adopted:

a) BSCE members are requested to urge the appropriate authorities to revise existing national maps according to Annex 15 of the ICAO Aeronautical Information Service. Members of the BSCE working group are urged to send copies of the maps to the chairman of the working group.

b) BSCE members are urged to ask the appropriate authorities to work up recent information concerning bird sanctuaries, and areas of ornitnological importance for drawing up a corresponding European map, but the appropriate authority should decide on its own responsability whether there is need for publication of such maps.

c) BSCE members are urged to ask the appropriate authorities to draw up airport vicinity maps according to ICAO Annex 15, in close cooperation with airport authorities. BSCE members should send copies of such maps to the chairman of the working group.

Deadline: 1st January 1990 (regarding a), b), and c))

d) BSCE members are urged to ask the appropriate authority to improve the procedures of birdstrike prevention for aircraft flying at low level on the basis of the standardized radar observations and exchange birdstrike warnings (BIRDTAM) concerning largescale bird movements in a standardized format via the ATC or WX-networks.

14. COOPERATION WITH ICAO

J.L. Santamaria informed the meeting about the actual status of the ICAO birdstrike information system stating that about 4500 cases are collected each year and that an analysis of all the cases are reported to the states. He invited all the members of BSCE to urge their administration to send the reports as soon as possible. He at the same time indicated that ICAO would like to collect all the data in the middle of the year so that the analysis could be completed by the end of the year. Furthermore ICAO is trying to revise the airport manual through the cooperation with experts coming from Canada, Australia, and the US.

Regarding the question, "ICAO Workshops on Bird Hazard to Aircraft", the Chairman informed the meeting that there was to be a workshop in Nairobi next autumn (1989) and that BSCE at the last workshop meeting in Mexico

City was represented by Mr. Thorpe and Dr. Hild and that the observations made by the latter concerning the running of the meeting were contained in wp/35.

On behalf of ICAO J.L. Santamaria thanked Dr. Hild for the wp. He added that ICAO would pass the information as soon as possible regarding future workshop meetings and would rely on the BSCE Chairman to pass the information to members of BSCE likely to attend.

15. "EEC COUNCIL DIRECTIVE ON BIRD CONSERVATION". ACTUAL STATUS OF THE IMPLEMENTATION"

After the presentation by the Chairman it was agreed to retain the recommendation from the previous meetings although the chairman had not had any response from other countries as to the question from the EEC.

C. Thomas, UK, mentioned that there might be plans to take certain land out of milk production in the EEC and he wondered if anyone was monitoring this so that if there was land surrounding an airport the birdstrike hazard question would be included in the consideration for removal of certain types of land.

The Chairman was aware of the trend in the EEC countries to reforest agricultural land and indicated that if the plans did materialize the Danish delegation would present a paper on this subject at the next meeting.

16. COOPERATION WITH ECAC

The Chairman mentioned that in the past both Vital Ferry and Elisabeth Dallo were the contact persons to ECAC. The Chairman indicated that he most probably would be in a position to act as rapporteur to ECAC the Danish Director General of Civil Aviation being the chief of the Technical Committee of ECAC.

17. WORKING GROUP AERODROME

The Chairman's report was presented by H. Helkamo, Finland.

The new third edition of the green booklet "Some Measures Used in Different Countries for Reduction of Bird Strike Risk Around Airports (May 1988, Helsinki), was prepared by the Working Group and delivered to BSCE members during the meeting.

After some discussions the following recommendations were adopted by the meeting:

a) BSCE members should be reminded that new methods of scaring birds should be tested scientifically and not subjectively.

b) BSCE members should send their contribution for the next edition of the green booklet to the Chairman of the Aerodrome Working Group not later than 30th June 1989.

18. COOPERATION WITH IATA AND OTHER ORGANIZATIONS

The Chairman pointed out that IATA has been represented at the meeting and took this as a token of the good relationship with IATA.

19. WP/10 "TERMS OF REFERENCE OF THE STEERING COMMITTEE OF BSCE"

The Chairman presented wp/10, "Terms of Reference of the Steering Committee of BSCE" indicating that the reason for change is that the Steering Committee would like to strengthen the work done within the Steering Committee and be able to retain J. Hild as member.

The meeting approved the proposal by the Steering Committee.

20. WORKING GROUP ANALYSIS

The Chairman's report on the activities of the Working Group Analysis was presented by J. Thorpe, UK, who especially mentioned that H. Wessum from the Netherlands had resigned as a Vice-Chairman and was replaced by B. Larsson, Sweden.

The following recommendations were adopted by the meeting:

a) That military "low level" en-route strikes should be analysed separately by BSCE members. A separate set of forms will be necessary.

b) That details of military accidents and serious incidents should be sent by BSCE members to the German Military Geophysical Office (Dr. Becker) for inclusion in a paper describing serious strikes to military aircraft.

c) BSCE members should urge that means be provided to enable civil data to be analysed by reporter's occupation. Members who already have this information should urge the appropriate authorities to provide it to ICAO.

d) That the civil BSCE members should ask their major airlines for their movement data at airports in the system. The data would be combined with strike reports from airports and be passed to the Working Group Chairman so as to indicate those airports where a bird strike problem exists.

e) BCSE analysis should be sent by members as follows:

Civil Data to Working Group Chairman
for 1985 by 30 June 1988
for 1986 by 30 June 1988
for 1987 by 30 November 1988

Military Data to Dr. Becker
for 1987 by 30 November
for 1988 by 30 November

21. WORKING GROUP STRUCTURAL TESTING OF AIRFRAMES

The Chairman's report on the activities of the working group for Structural Testing of Airframes was presented by P. Chalot, France.

To a question from T. Brough, UK, Mr. Devaux answered that the gulls used during the experiments, mentioned in wp/33, were Herring gulls coming from the South of France. It was found that the gull was a more representative flying bird than the chickens used until now. That was the reason for choosing the gulls.

Mr. Chalot added that they were planning for a meeting to take place in Paris for testing airframes and urged people who wanted to attend the meeting to give him their names and addresses.

On the request of Mr. Chalot the meeting agreed to change the name of the working group to "Testing of Airframes and Engines".

R. Speelman, USA, informed the meeting that a conference is planned to take place in the week of the 16th January 1989 in Monterey, California, which will address specifically the subject of aircraft windshield systems, both civil and military, the design, the design process, the testing, testing requirements including the specific target of bird strikes and cover performance measurements and performance assessment technics, testing relative to performance and maintenance and durability. Applications for attending the meeting should be send to R. Speelman.

The following recommendation was adopted:

BSCE members should seek information on the retention of birdstrike capability after extended in service usage of engines and airframes.

The Chairman would see to that the terms of reference of the working group were changed according to the change of the title of the working group.

22. SUB-GROUP ON FEATHER IDENTIFICATION

The rapporteur's report on the activities of the sub-group was presented by Tim G. Brom, the Netherlands.

According to the wish of the participants in the sub-group meeting the meeting agreed that the sub-group be raised to working group level and the name changed from "Feather Identification" to "Bird Remains Identification Working Group".

The meeting unanimously elected Tim G. Brom as a Chairman of the abovementioned working group.

It was understood that after consultations with the chairman of the working group the Chairman of BSCE should work out the terms of reference of the set group.

23. THE RADAR WORKING GROUP

L. Buurma, the Netherlands, presented the Chairman's report from the Radar Working Group and added that the radar booklet would be issued in the second half of this year. It would be available to interested persons who approached Buurma and would be presented at the next BSCE meeting.

The following recommendations were adopted by the meeting:

a) The BSCE members should urge that international cooperation with respect to further development of electronic assessment of bird hazards by radar be intensified.

b) When quantifying bird movements, the BSCE members should urge the appropriate authority to put emphasis on the proper inclusion of bird numbers at low level.

c) BSCE members should approach the industry to develop, commercially, a small bird radar according to BSCE specifications being drafted for inclusion in the radar booklet.

24. THE MIKE KUHRING AWARD

On the motion of H. Dahl it was decided that the 7th Mike Kuhring Award be conferred on Jochen Hild, FRG, in recognition of his activities during the whole existence of the BSCE from the very beginning and especially for his activities as the Chairman of the "Bird Movement Working Group" and for having represented the BSCE at various ICAO Workshop meetings.

J. Hild said that he was most honoured to receive the award and expressed his sincere thanks for it. He considered himself as one of the oldest disciples of Mike Kuhring who was the locomotive of all progress and effort in BSCE for many years. He went through the founding and history of the organization beginning with the bird hazard meeting which was arranged in 1963 in Nice and followed by the first civil military bird strike meeting in 1966 in Frankfurt. He paid tribute to the first BSCE Chairman, Colonel Tweisel, the Netherlands, and to the succeeding chairmen, hoping that the success for flight safety would continue in a period where it will be more necessary than ever to reach a fruitful and effective cooperation and coexistence between the necessities and demands of flight safety and environmental protection.

25. PLANNING FOR FUTURE MEETINGS OF BSCE

H. Dahl announced that the 20th BSCE meeting would be held in Helsinki, Finland, in the week that starts on 21 May 1990. He had also been in touch with delegates from other countries in order to make arrangements for future meetings in the nineties.

On behalf of the Finnish delegation Helkamo invited the meeting to Finland.

26. ELECTION OF CHAIRMAN OF BSCE

The meeting reelected H. Dahl for another period.

27. OTHER MATTERS

T. Caithness, New Zealand, informed that an international congress would be held in New Zealand in December 1990. The title is "The World Of Birds - A Southern Perspective" and it will comprise the 20th International

Ornithological Congress and the 20th World Conference of the International Council for Bird Presenrvation. The congress will be held in Christchurch, New Zealand, from 2-9 December 1990. Applications for attending the meeting should be forwarded to Mr. Caithness.

At the request of B. Larsson, Sweden, the Chairman undertook the task of working up a list of contact persons from each country in order to facilitate the contact between the various countries. This list would be presented as a working paper by the Chairman at the next meeting

A video film "Following Soaring Bird Migration from the Ground, Motorized Glider and Radar at a Junction of Three Continents" was shown by Y. Leshem, Israel.

28. TERMINATION OF THE MEETING

H. Dahl expressed the gratitude of all the participants of the meeting, especially his own gratitude for the work done by the Secretariat of the meeting and presented a gift to each member of the Secretariat. He paid tribute to the very effective way in which the meeting had been arranged by the Spanish Administration and to the social arrangements such as the ladies' trip and the evening with dinner and Flamenco dancers. He also thanked the City of Madrid for giving them the possibility of tasting the delicious Spanish wines and thanked the Halkon Company for providing the meeting with coffee and cookies during the whole meeting.

He thanked all the participants for the work they had done during the meeting and added that he was quite impressed by the number of working papers which amounted to 43 and said that although the meeting had not succeeded in achieving the final instrument in order to solve the bird strike problem in the various countries a good step forward had been taken during the conference. He paid in particular tribute to the valuable Spanish contribution to the working papers.

His special thanks went to the members of the Steering Committee and especially to the Vice-Chairman, J. Thorpe, and E. Schneider who had been of utmost help to him during the meeting.

The Secretary General of the Civil Aviation Administration in Spain, Don Mederos, said goodbye to the participants of the meeting with the following words:

"We have had the honour to be the country that has organized this 19th BSCE meeting that ends today. The fact of having the presence of representatives from countries with a high level of skill and experience in the BSCE in conflicted areas with bird strike control has permitted this meeting to benefit from it. We have realized that bird strike against aircraft is a problem which can be foreseen to a certain extent. But at these meetings information is exchanged between different countries and therefore we get to know the success of different systems to reduce this potential hazard. The line of defence balance to guard the different specimen in the ecological system for human and cultural benefits have been maintained at this meeting. I wish to animate you to persist in the improvement of the system you are working on. This 19th BSCE meeting has had a high level and which sometimes is more important it has been held with future prevision. I cannot assure you that the General Director of Civil Aviation will take into consideration and will apply each recommendation proposed by the working groups. Finally I wish to thank everybody for this meeting and for the cooperation of companies and congratulate the authorities in Spain for their organization of this meeting".

H. Dahl finished the meeting by declaring the meeting closed.